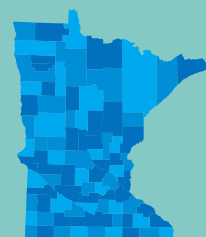


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# Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List

2020 Assessment and Listing Cycle



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# Foreword

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Minnesota is blessed with abundant water resources. Our lakes, rivers, and streams play a vital role in the state's economy and the richness of the quality of life residents and visitors enjoy. The health of Minnesota's environment and enormous opportunities for water-related recreation depend on good water quality.

Since the Clean Water Act became law in 1972, very significant and often dramatic improvements in the water quality of Minnesota's surface waters have been accomplished. Notable examples include the Mississippi River below the Twin Cities, the Rainy River below International Falls, and the recent improvements to dissolved oxygen concentrations in the Minnesota River. Most of these gains can be attributed to vast improvements in domestic and industrial wastewater treatment.

In spite of these success stories, many Minnesota lakes and streams do not fully support beneficial uses such as swimming and fishing. The contribution of pollutants from nonpoint sources, from agriculture, construction and development sites, forestry, urban runoff, etc., is now the major reason that many of Minnesota's waters are considered impaired. The prevention and control of nonpoint source pollution remains one of the Minnesota Pollution Control Agency's (MPCA), and the public's, greatest challenges.

The MPCA is charged under both federal and state law with protecting the water quality of Minnesota's lakes, rivers, streams, and wetlands. It is the responsibility of the MPCA to monitor Minnesota's water bodies, to assess water quality, and to report the results to the public. This task extends to documenting the water quality "success stories," as well as identifying those water bodies that still need improvement.

This Guidance Manual was developed to help federal, tribal, state, and county staff, and the public in general, understand the water quality assessment process, and how Minnesota assesses water quality. The methodologies in this Guidance Manual have been refined in order to derive the most information, value, and benefit possible from available water quality data. The information created in the assessment process becomes the basis for evaluating the current status of Minnesota's water quality, identifying waters that are either impaired and need restoration or need further protection to prevent impairment, and tracking progress over time.

This Guidance Manual will be updated as assessment methods improve and as new pollution problems emerge that require assessment. Comments and suggestions from readers are encouraged and will be used to help improve the Guidance.

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# Abbreviations, acronyms, and symbols

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AUID	Assessment unit identification
BCC	Bioaccumulative Chemicals of Concern
BCG	Biological Condition Gradient
BOD	5-day Biological Oxygen Demand
CC	Chronic Criteria
chl- <i>a</i>	Chlorophyll- <i>a</i> , corrected for pheophytin
CS	Chronic Standard
CWA	Clean Water Act
DC	Domestic consumption
DNR	Minnesota Department of Natural Resources
DO	Dissolved oxygen
EPA	U.S. Environmental Protection Agency
EQ <i>u</i> IS	Environmental Quality Information System
GLI	Great Lakes Water Quality Initiative
HDS	Human Disturbance Score
HH-WQS	Human Health-based Water Quality Standards
IBI	Index of Biotic Integrity
IWM	Intensive watershed monitoring
LTRMP	Long Term Resource Monitoring Program
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MPCA	Minnesota Pollution Control Agency
NHD	National Hydrographic Data
PCB	Polychlorinated biphenyls
PJG	Professional Judgment Group
PFOS	Perfluorooctane Sulfonate
QA/QC	Quality Assurance/Quality Control
RES	River Eutrophication Standards
RNR	River Nutrient Region
TALU	Tiered Aquatic Life Uses
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSS	Total Suspended Solids
USGS	United States Geological Survey
WAT	Watershed Assessment Team
WQS	Water Quality Standards

# Preface to the 2020 revision of the Guidance Manual

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In this edition of the Guidance Manual for Assessing the Quality of Minnesota Surface Waters, the MPCA made one substantive addition since the previous version published in 2018: the incorporation of a 2018 EPA study aluminum toxicity in Section V.A.1.a.

One additional addition was made after this document was made available for public comment: the inclusion of numeric biological criteria for the assessment of fish and macroinvertebrate communities in rivers and streams (Table 12).



# I. Introduction

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## A. Background

Minnesota is blessed with abundant water resources. Our lakes, rivers, and streams play a vital role in the state's economy and the richness of the quality of life residents and visitors enjoy. The enormous opportunities for water related recreation these resources provide, such as aesthetic enjoyment, swimming, fishing, boating and canoeing depend, to a great extent, on good water quality. Within Minnesota's borders lie the headwaters of three major continental watersheds, the Great Lakes/St. Lawrence River, the Mississippi River, and the Red River of the North/Hudson Bay Watersheds. Thus, Minnesotans have the privilege and, with that, the huge responsibility of living "upstream" of millions of downstream users of these major waterways. Minnesota's water resources include about 105,000 river miles, 4.5 million acres of lakes and reservoirs including approximately 1.4 million acres of Lake Superior in Minnesota, and about 9.3 million acres of wetlands.

The Minnesota Pollution Control Agency (MPCA) is charged under both federal and state law with the responsibility of protecting the water quality of Minnesota's lakes, rivers, streams, and wetlands. One goal of the MPCA is to preserve the existing high quality of water bodies that are meeting standards, so beneficial uses are maintained. However, too many surface waters receive enough pollutant loading from a variety of sources that they do not meet one or more water quality standards (WQS). If the extent of the violations of standards exceed the guidelines spelled out in this Guidance Manual (Guidance), those surface waters are considered to be "impaired." Another goal of the MPCA is to improve the quality of impaired waters so WQS are met and beneficial uses are maintained and restored, where these uses are attainable.

## B. About the TMDL list, Assessment and Listing Cycle, and Integrated Report

The federal Clean Water Act (CWA) requires states to adopt WQS to protect waters from pollution. These standards define how much of a pollutant can be in the water and still meet beneficial uses, such as drinking water, fishing, and swimming. WQS are the fundamental tools used to assess the quality of all surface waters. For more detailed information regarding standards see <https://www.pca.state.mn.us/water/water-quality-standards>. States must monitor and assess the water quality of their waters to identify those that are "impaired", i.e., not fully supporting their beneficial uses. Section 303(d) of the CWA requires states to publish and update a list of impaired waters for which a Total Maximum Daily Load (TMDL) Study is needed. This list, known as the "303(d) List" or "TMDL List" is updated every two years via the assessment of water quality data and an extensive public participation process. The draft TMDL List is developed by the MPCA and submitted to the U.S. Environmental Protection Agency (EPA) for final approval. The two-year timeline for assembling and submitting the draft TMDL List is known as the "assessment and listing cycle." This Guidance has been prepared to reflect the 2020 Assessment and Listing Cycle.

The CWA also requires states to submit a report on the status of all of their waters to help measure progress toward the national goals of fishable and swimmable waters. This "Integrated Report" includes Minnesota's Impaired Waters List – an accounting of all known impaired

waters, not just those requiring TMDLs. The Inventory of Impaired Waters includes those waters needing a TMDL plan, those for which a plan has already been developed and approved by EPA, and water bodies that do not require a TMDL (impaired by a non-pollutant alteration [4C] such as a dam or impoundment, or impaired because natural background exceeds the standard where impacts from human activity are insignificant [4D]). The Integrated Report also includes a narrative component and information about waters that are meeting beneficial uses and also programmatic information about protection and restoration efforts. As part of the assessment process and the development of the Integrated Report, all waters for which sufficient data have been collected to allow a review are assigned to a category of impaired, unimpaired, or insufficient information to determine impairment status according to EPA-established categories (Appendix A). To view the MPCA's most recent 303(d) Impaired Waters List and 305(b) Narrative Report see <https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list>.

## C. Monitoring and assessment approach

The MPCA conducts a variety of surface water condition monitoring activities focused on providing critical information to assess the condition of Minnesota's water resources. This information is also used to assess potential and actual threats to water quality and to evaluate the effectiveness of management activities taken to address impairments and other threats to water quality. Monitoring conducted by other local, state, and federal agencies, citizen monitoring as well as remote sensing data are also used for this purpose. For more details on the MPCA's monitoring strategy, see <https://www.pca.state.mn.us/water/water-quality-monitoring-strategy>.

The MPCA's primary condition monitoring activities are organized around Minnesota's 80 major watersheds. The watershed monitoring approach involves intensive monitoring on a subset of major watersheds every year. The MPCA has implemented a schedule for intensively monitoring each major watershed once every 10 years, and the watershed outlets annually. These result in the identification of waters that are impaired and need restoration as well as waters that need further protection to prevent impairment. Monitoring is followed by TMDL prioritization and protection strategy development at the major watershed scale, and ongoing implementation. See <https://www.pca.state.mn.us/water/watershed-approach-restoring-and-protecting-water-quality> for a more in-depth discussion of the watershed approach and for a map of the 10-year watershed monitoring schedule. For information on TMDL priority rankings as they pertain to reporting to EPA, see Appendix B. An important feature of the watershed approach is the fact that restoration and protection planning and associated implementation will occur in *all* watersheds; the identification of an impaired status is not the key trigger for follow-on planning and implementation.

Until 2010, the MPCA assessed the condition of the state's waters via a biennial, statewide assessment process. With the advent of the intensive watershed monitoring (IWM) approach, the MPCA faced a need to revise the assessment process to align with the watershed monitoring approach, including the 10-year schedule and the increased volume of data generated during watershed monitoring.

An annual assessment process has been designed to keep up with the monitoring work and reflect the more detailed monitoring data available in the watersheds where IWM has been completed. The development of an annual assessment process has been critical to the MPCA's implementation of the overall watershed approach. With assessments taking place immediately

following completion of IWM, the entire process of monitoring-assessment-restoration-protection can be completed within 10 years, at which time the watershed comes up for monitoring again as part of the next scheduled 10-year rotation. In addition, the revised process encourages earlier and more meaningful local involvement in assessment.

Additionally, MPCA and Minnesota Department of Natural Resources (DNR) collaborated on the assessment of aquatic life in lakes utilizing a lake fish Index of Biotic Integrity (IBI) and a review of existing plant data. Sampling has been aligned so that aquatic life assessments will be completed annually following the watershed monitoring approach.

In 2013, a large river monitoring strategy was initiated to complement the watershed approach for the monitoring, assessment, and CWA reporting of water resources within Minnesota. For the purposes of fulfilling our monitoring and assessment objectives, large rivers are defined as large mainstem rivers that flow through multiple major watersheds and, therefore, were not satisfactorily represented within the watershed approach. In Minnesota, these include the St. Croix, Minnesota, Upper Mississippi, Red, and Rainy Rivers. These rivers will be monitored and assessed longitudinally on a rotating basis once every 10 years. The Lower Mississippi (below Upper St. Anthony Falls) also meets the definition of a large river but is treated separately due to ongoing interstate efforts to develop a consistent and comprehensive monitoring strategy to fulfill CWA objectives for interstate waters of the Mississippi River. For more on the MPCA's large river monitoring, see <https://www.pca.state.mn.us/water/large-river-monitoring>.

Some monitoring, namely monitoring of toxic parameters, continues to occur on a statewide basis. Assessment of those parameters is done statewide every two years, to reflect the monitoring design. Watershed assessments focus primarily on the aquatic life and recreation beneficial uses. Statewide assessments focus primarily on aquatic consumption and aquatic life toxicity. Every two years the watershed and statewide assessment results are packaged together into the proposed TMDL List and Integrated Report. For the 2020 Assessment and Listing Cycle, the watersheds and large rivers are:

**Assessed in 2018**

Kettle River  
Mississippi River – Brainerd  
Mississippi River – Sartell  
Otter Tail River  
Upper St. Croix River  
Rainy River – Large River

**Assessed in 2019**

Blue Earth River  
Cottonwood River  
North Fork Crow River  
Pomme de Terre River  
Lower Rainy River  
Rainy River – Rainy Lake  
Rapid River  
Redwood River  
Snake River  
St. Croix River – Large River

While the MPCA's monitoring and assessment efforts primarily follow the major watershed schedule, interested parties are able to propose additional listings outside of the watershed schedule during the call for data or public notice of the draft TMDL List. This proposal process is intended to accommodate instances when assessment and listing outside of the watershed schedule is necessary for a locally led initiative to move forward. To honor the watershed schedule and maintain the integrity of the systematic approach to monitoring/assessment, TMDL development, and implementation, any proposals for listing outside of the watershed schedule must 1) explain why moving forward with assessment is necessary prior to the comprehensive watershed assessment, 2) document how the efficiency and coordination that is lost by deviating from the watershed approach will be offset by a local benefit, and 3) demonstrate that the MPCA's assessment methods in this Guidance were followed for the monitoring, analysis, and comparison of the data against state standards. The MPCA will review the proposal and make the determination regarding impairment and listing prior to submitting the draft list to EPA for approval.

## II. Purpose and scope

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### A. About the Assessment Guidance

The purpose of this Guidance is to define the required data and information and lay out the criteria by which water bodies are assessed to determine if beneficial uses are supported.

The scope of this Guidance includes methods for assessing surface waters for the following beneficial uses:

- Aquatic life (toxicity-based standards, conventional pollutants, biological indicators)
- Drinking water and aquatic consumption (human health-based standards)
- Aquatic consumption (fish-tissue and wildlife-based standards)
- Aquatic recreation (*Escherichia coli* – *E. coli* – bacteria, eutrophication)
- Limited value resource waters (toxicity-based standards, bacteria, conventional pollutants)

### B. Disclaimers and future changes to the Guidance

To people not involved with conducting water quality assessments, the determination of an impaired condition would seem to be a straightforward process: waters are either impaired or not impaired. However, the assessment process is very complex and it includes a certain amount of uncertainty. The MPCA must consider many different types and sources of data, different categories of pollutants, different uses of surface waters, the variability in natural systems, and many other variables. The goal of this Guidance is to accurately and completely describe the assessment methods, and to make the assessment process as clear and understandable to all parties as possible. Nevertheless, questions about the assessment process will invariably arise that the Guidance fails to answer. Readers are encouraged to access the many resources listed in Section XI, including MPCA staff, for additional information. Two MPCA products, which may be especially useful and related to this Guidance, are the Volunteer Surface Water Monitoring Guide (MPCA 2003) (<http://www.pca.state.mn.us/water/monitoring-guide.html>) and the Surface Water Data website ([http://cf.pca.state.mn.us/water/watershedweb/wdip/search\\_more.cfm](http://cf.pca.state.mn.us/water/watershedweb/wdip/search_more.cfm)). The Monitoring Guide provides information on planning a monitoring program, as well as data quality and management. The Surface Water Data website allows Minnesotans to access environmental data on surface waters statewide.

This Guidance does not affect the rights and administrative procedures available to all affected or interested parties. The Guidance is not part of any water quality rule – it does not have the force of law. It serves to guide the interpretation and application of current WQS that are in water quality rules. If any party feels that an MPCA decision based on the Guidance is not supported by the facts, or they have any issue related to the MPCA's use of the Guidance, that party can comment or challenge the MPCA's actions in the following ways:

- Directly contact MPCA staff, management, or the Commissioner, orally or in writing.
- Request a contested case hearing if the issue involves an MPCA permit action, or any other MPCA action for which a contested case hearing is an appropriate forum to resolve the concern
- Challenge the MPCA action in the appropriate legal jurisdiction

The MPCA updates this Guidance every two years since that is the current EPA mandated schedule for preparation of both the Integrated Narrative Report and the 303(d) List. The MPCA involves the public when major changes to the Guidance are being considered and invites the public to comment on this Guidance on the same schedule as the 303(d) Impaired Waters List.

## **C. Other standards**

Other toxic or conventional pollutants that are found to exceed WQS will be assessed following equivalent methodologies discussed in this Guidance, depending on the type of pollutant. Methodologies will be developed and included in this document as new pollutants are added to the assessment process.

### III. Steps in the assessment process

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As noted in the Introduction, the MPCA redesigned the assessment process during the time between the 2010 and 2012 listing cycles. As mentioned in the agency's Continuing Planning Process, the shift to watershed-based monitoring and restoration/protection approach with a rotating 10-year watershed schedule resulted in a need for annual assessments. This adjustment along with the large amount of data that this new approach provides presented a timely opportunity to redesign the assessment process (MPCA 2010). As discussed in Minnesota's Water Quality Monitoring Strategy 2011-2021, this process is designed to combine computerized data analysis, expert review, and internal and external partner input to use all available data and information to determine the appropriate assessment decisions for a number of beneficial uses (MPCA 2011).

The redesigned process expands upon the data analysis steps of the previous assessment process. While this new process focused on the aquatic life use assessments in rivers and streams, concepts of the redesigned process have also influenced how other designated uses (e.g., aquatic recreation) are assessed. Additional reviews at the parameter level and the addition of an internal comprehensive review, prior to the professional judgment group meeting, were the largest changes. These changes reflect the increased volume and complexity of the data gathered during the IWM effort, and help ensure a robust decision about the appropriate management actions to be pursued for each assessment unit (water body, or AUID) in the planning and implementation phases of the watershed approach (i.e. restoration for impaired waters, and protection for unimpaired waters). It also stressed and engrained the importance of quality assurance and quality control at every step in the process. Further detail on the specific steps in the process is included below. A note should be made that the aquatic consumption (fish) assessment at this time utilizes only the first two steps in the process.

#### A. Data compilation

The initial step in the process is a computerized screening that identifies monitoring results collected on AUIDs over the appropriate period of record and compares each data point to water quality criteria, summarizes the number of data points that exceed the criteria, the total number of data points, and the number of years of data. This step produces a parameter-specific summarization (e.g., dissolved oxygen (DO), Fish IBI, and *E. coli*). For more information on the sources of data that the MPCA uses, see Appendix C.

#### B. Desktop assessment

The desktop assessment involves a review of data and summaries by resource-specific staff (e.g., water quality staff review chemistry data, biologists review stream biological data, DNR review lake biology) for water bodies within a specific major watershed, or 8-digit hydrologic unit code watershed (HUC-8). This review considers multiple lines of evidence – review of flow conditions, precipitation, land use, habitat, etc. – in addition to the summarizations to ascertain the quality of the dataset (temporal and spatial completeness, etc.) and whether the parameter is meeting or exceeding the appropriate criterion. During this process, any candidates for delisting or natural background review are identified and work begins to determine if those AUIDs meet the criteria to be removed from the Impaired Waters List.

## **C. Watershed Assessment Team (WAT)**

The WAT includes desktop assessors, regional watershed project managers, stressor identification staff, and other state agency personnel involved in the HUC-8 assessments. The WAT meets to review each AUID in the watershed, considering comments and parameter-level evaluations from the desktop assessment as well as supplemental information, to reach an overall use-support decision. Delisting and natural background candidates may also be identified at this time.

## **D. Professional Judgment Group (PJG)**

The PJG is comprised of WAT and external parties (local data collectors, local government units, etc. as determined by the MPCA regional watershed project manager). This group meets to discuss the results of the WAT meeting for a specific HUC-8. Prior to the PJG meeting, the results of the WAT meeting are distributed to all invitees, including parameter-level evaluations, overall use-support recommendations and all comments. Invitees are asked to identify AUIDs they wish to discuss; an agenda is developed based on these submissions. The format of this meeting, instead of an exhaustive review of each AUID, is an overview of the process, a general discussion of the watershed and major subwatersheds and a review of requested AUIDs, delisting and natural background candidates. The results of this meeting are final use-support determinations.

The analyses and recommendations for each AUID are documented in a database and archived following the completion of the assessments. Throughout the annual assessment process, care is taken to maintain consistency among the HUC-8 assessment meetings and decisions. This is accomplished via internal training and quality control, the assignment of individual staff to multiple HUC-8 data sets for the expert review and desktop assessments, and oversight and guidance provided by a technical team and a management team charged with ensuring quality data analysis and consistency among watershed assessment discussions and decisions.



## IV. General aspects of data assessment

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### A. Delineation of reaches, lakes, and wetlands

Assessments of use-support in Minnesota are made for individual water bodies. The water body unit used for stream reaches, lakes, and wetlands is called the “assessment unit.” A stream assessment unit usually extends from one significant tributary to another or from the headwaters to the first significant tributary and is typically less than 20 miles in length. Main-stem large rivers utilize hydrologic unit boundaries (10 digit HUC) as the initial assessment unit. A stream or river reach may be further divided into two or more assessment units when there is a change in the use classification (as defined in Minn. R. ch. 7050), or when there is a significant morphological feature such as a dam, or a lake within the river.

The MPCA uses the 1:24,000 scale high resolutions National Hydrography Dataset (NHD) to create geospatial data to represent stream and lake assessment units. All of our assessment units are indexed to the NHD, or have had custom shapes created for addition to the NHD. The high resolution NHD was created from 1:24,000 scale United States Geological Survey Digital Line Graphs and DNR stream and lake data.

Each water body is identified by a unique water body identifier code called an assessment unit identification or AUID. For streams, the code is comprised of the United States Geological Survey (USGS) 8-digit sub-basin code plus a three-character code that is unique within each sub-basin. It is for these specific reaches that the data are evaluated for potential use impairment. The MPCA consults with border states during the assessment process and documents reasons for any discrepancies in assessment determination between Minnesota and the specific border state.

The DNR’s Protected Waters Inventory is the source for lake and wetland identifiers. DNR uses an 8-digit identifier for water bodies, consisting of a 2-digit prefix that represents county, 4-digit number identifying a lake, and a 2-digit suffix that represents either a whole lake (-00) or representing a specific bay of a lake (-01, -02, etc.). This 8-digit identifier is used by MPCA to represent an assessment unit for lakes and wetlands. Water bodies determined to be wetlands will not be assessed using the eutrophication factors discussed in Section VIII. C; factors used to identify wetlands can be found in Appendix D.

For the purposes for identifying water bodies as either wholly or partially within federally recognized Indian reservations, the MPCA uses the U.S. Census Bureau’s spatial data on American Indian/Alaska Native Areas/Hawaiian Home Lands, except with respect to the Mille Lacs Reservation where the State disagrees with the tribe and the federal government on the boundaries of the Mille Lacs Reservation. Waters that flow through, or are completely within, reservation boundaries receive a special notation in Minnesota’s Impaired Waters List. Those lakes and streams that serve as a boundary between state land and reservation land do not receive notation and are treated, in assessment and listing, the same as border waters between neighboring states. The U.S. Census Bureau’s data are public and can be downloaded at <https://www.census.gov/cgi-bin/geo/shapefiles/index.php>. For more information on the MPCA’s approach for assessing and communicating the quality of waters that occur partially or wholly within federally recognized Indian Reservations, see Appendix E.

## **B. Period of record**

The MPCA generally uses data collected over the most recent 10-year period for all the water quality assessments considered for 303(d) impairments. Years of record are based on the USGS water year, October 1 of one year through September 30 of the following year. It is preferable to split the year in the fall, when hydrological conditions are usually stable, than to use calendar years. The MPCA uses a period as long as 10 years in its assessments because it provides reasonable assurance that data will have been collected over a range of weather and flow conditions and that all seasons will be adequately represented. From a practical standpoint, the 10-year period means there is a better chance of meeting the minimum data requirements. A full 10 years of data are not required to make an assessment.

In accordance with SF844 Sec. 122 subd. 6., the MPCA will take into consideration recent relevant pollution reductions resulting from controls on municipal point sources and nonpoint sources. In practice, this means that, if MPCA is aware of projects or facility changes that would result in a measureable improvement in the receiving water quality, the MPCA will consider these improvements in its assessment decision-making. Depending on the potential impact to water quality realized by these improvements or changes, the MPCA may: 1) base its assessment decision solely on data collected post-project(s)/change(s); 2) make its assessment decision by placing more weight on data collected post-project(s)/change(s); or 3) defer an assessment decision altogether until sufficient post-project(s)/change(s) data can be obtained.

## **C. Uncertainty in water quality assessments**

The MPCA is very cognizant of the hazards of making assessments with limited data. One benefit of the watershed monitoring approach is that it provides a more robust dataset for assessment. The selection of the minimum data requirements for water quality assessment is clearly a compromise between the need to assess as many water bodies as possible and the importance of minimizing the probability of making an erroneous assessment. The methods described in this Guidance deal with this problem in a variety of ways, depending on the pollutant category. Nonetheless, some level of uncertainty is part of every analysis of water quality data. There is always a chance that a water body will be assessed as impaired when in fact it is not or assessed as un-impaired when in fact it is. The number of data points the MPCA requires as a minimum for water quality assessments is small in the context of statistical analyses of uncertainty. The approach used by the MPCA to make impairment decisions, which is a screening of the data using the impairment thresholds, followed by a review by professionals, makes the best use of limited data. This is the approach recommended by the EPA.

Essentially all assessments are subject to review by a team of professional water quality experts (see previous section). Review of the data by professionals is a very important part of minimizing erroneous impairment determinations, and this review would be required whether statistical tests are used or not. The possible erroneous placement of a water body on the 303(d) List is a concern because of the regulatory and monetary implications of 303(d) listing. It has been the experience of the MPCA that very few water bodies have been incorrectly determined to be impaired.

When the professional review of data collected for a lake or stream finds conflicting or inadequate information to make a confident assessment, and more monitoring could resolve the need, notes are recorded in a database and discussions are had with monitoring programs to determine if additional sampling can be pursued.

## D. Data sources and quality

Data for assessments are queried primarily from MPCA's water quality data management system, EQUIS (Environmental Quality Information System); a limited amount of data from outside that system is also included in the process. However, to allow for the external data to be included in the process, it must be submitted to MPCA in time for incorporation into the assessment tables; this date is announced via a call for data and is typically November 1 prior to the start of the assessments.

The data used in assessment decisions must be of reliable quality and QA/QC protocols must be carefully followed for each step along the way from field sampling to lab analysis to data management in order to reduce the introduction of errors. Monitoring and data management at the MPCA are performed in accordance with the requirements specified in a Quality Management Plan approved by the EPA and available for review on the MPCA website at <http://www.pca.state.mn.us/index.php/about-mpca/mpca-overview/agency-strategy/mpca-quality-system.html>. For more information on data sources see Appendix C.

## E. Dataset quality and parameter-level evaluation

As noted previously, a key step in the assessment process is to determine if individual parameters meet or exceed their criteria (numeric or narrative standards) or have insufficient data to make that determination. In addition to this comparison against standards, the evaluator also makes a determination of the confidence of the parameter assessment, assigning a low, medium, or high quality rating. These results are stored in a working database and used in the WAT reviews and PJG meetings, with supporting information, to make the final use-support determinations.

For some parameters, the parameter-level evaluation is equivalent to the final use assessment decision (e.g., aquatic consumption). For other parameters (e.g., conventional chemistry, biota, bacteria), the parameter-level evaluations are then used in conjunction with supporting data, including dataset quality, to make a final use-support determination. This will be discussed further in specific sections that follow (i.e. aquatic life, aquatic recreation).

To assist in parameter-level evaluations, MPCA has developed guidance for technical staff to use in their analyses ([Table 1](#)). The 10% and 25% exceedance frequencies referenced in [Table 1](#) for conventional pollutants are based on EPA guidance (EPA 1997) and have been used by the MPCA in assessments for many years. These thresholds are appropriate for the conventional category of pollutants for several reasons, including that none are considered "toxic" (or bioaccumulative), and all are subject to periodic "exceedances" because of natural causes. For example, total suspended solids (TSS) levels typically increase in streams after a rain event even in relatively undisturbed parts of the state, and DO can drop below the standard in low gradient rivers and streams for reasons other than pollution, such as the AUID is located downstream of or flows through extensive wetland complexes. These potential pollutants are also natural characteristics of surface waters, the fluctuations of which aquatic organisms have adapted to cope with over time. The existence and extent of natural exceedances are considered during the assessment process.

The dataset quality rating and notes about the parameter-level evaluation are recorded for use by the WAT and PJG in making the use-support assessment. The technical staff that completed the parameter-level evaluations participates in the WAT and PJG meetings.

**Table 1. Guidelines for parameter-level evaluations of conventional pollutants.<sup>1</sup>**

Assessment	Frequency of exceedances	Magnitude of exceedances	Duration of exceedances	Timing of exceedances <sup>2</sup>
Water chemistry parameter indicating unimpaired or supporting conditions	Less than 10% exceedances of chronic standard	Exceedances generally within 10% of water quality criteria	Continuous data or extensive grab sample data set indicates no or few instances of prolonged exceedance	Exceedances only occurring during extreme events such as 100 year flood (e.g., TSS) or severe drought conditions (e.g., DO)
Water chemistry parameter indicating potential impairment	Between 10 –25% exceedances of chronic standard	Exceedances generally greater than 10% but less than 25% of water quality criteria	Continuous data or extensive grab sample data set indicates some instances of prolonged exceedance	Exceedances only occurring during periods in which they are most likely to occur (e.g., before 9 am, 7Q10 low flow, storm events, etc.); not counting extreme events above
Water chemistry parameter indicating potential for severe impairment	Greater than 25% exceedances of chronic standard	Exceedances generally greater than 25% of water quality criteria	Continuous data or extensive grab sample data set indicates chronic exceedance or many instances of prolonged exceedance	Exceedances occurring during periods (seasonal or daily cycle) in which they typically do not occur in addition to occurring in periods in which they are most likely to occur.

<sup>1</sup>Most parameters will have data sets that only allow frequency and magnitude to be evaluated. When sufficient data exist (e.g., continuous monitoring or extensive grab samples) or appropriate ancillary data (e.g., flow, precipitation) are accessible, duration or timing of exceedances may also be considered in the evaluation. The parameter-level evaluation requires best professional judgment to integrate information across all applicable columns.

<sup>2</sup>Based on evaluation of available flow data and/or precipitation records as well as observations made by monitoring staff.

## F. Reporting

MPCA reports the results of the assessments in a number of different formats, in watershed assessment reports (HUC-8), and in the integrated report to EPA. A brief description of each is below.

### 1. Watershed Monitoring and Assessment Report

Results of the assessments are compiled in a watershed monitoring and assessment report following the assessment determinations. AUIDs are discussed by subwatersheds and overall water quality conditions, potential stressors, and protection areas are identified. These documents inform the restoration (TMDL) and protection strategies that are developed by the agency. An example of a watershed assessment report can be found at <https://www.pca.state.mn.us/sites/default/files/wq-ws3-09030005b.pdf>.

### 2. Integrated reporting

The results of the assessments are reported as directed by guidance from EPA. The assessment decisions are loaded into EPA's Assessment, Total Maximum Daily Load (TMDL) Tracking and Implementation System (ATTAINS). Categories and subcategories used to classify each assessment unit can be found in Appendix A. Each designated use is identified as "full support," "not support," "insufficient information," or "not assessed" as a result of

the assessments. Impaired use/pollutant combinations without approved TMDL plans make up the 303(d) List. In conjunction with the ATTAINS upload, a narrative report to the U.S. Congress as required by section 305(b) of the CWA is developed. An Integrated Report consisting of the narrative report, the ATTAINS submittal, a 303(d) List and NHD indexed geospatial data are completed and submitted to EPA by April 1 every even year.

## V. Protection of aquatic life

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### A. Pollutants with aquatic life toxicity-based water quality standards

Protection of “aquatic life” with applicable Class 2 chronic standards means protection of the aquatic community from the direct harmful effects of toxic substances, and protection of human and wildlife consumers of fish or other aquatic organisms. This section of the Guidance deals with the former, the assessment of water quality for pollutants that have aquatic life toxicity-based chronic standards and acute or maximum standards that are always aquatic life toxicity-based. These standards are identified in Minn. R. 7050.0222 by the abbreviation, “Tox,” and by column headings, “Aquatic Life Chronic Standards or Maximum Standards,” in Minn. R. 7052.0100.

Surface waters are assessed to determine if they are of a quality needed to support the aquatic community that would be found in the water body under natural conditions. In general, two types of data are used in assessments: water chemistry data and biological data. Computer-generated summaries based on chemistry data and biological data are both considered, along with data quality indicators, in aquatic life use-support determinations. Aquatic life use-support determinations are completed for all parameters/indices below for streams and for specific parameters/indices as noted for lakes and wetlands.

#### 1. Toxic pollutants

The pollutants that have aquatic life toxicity-based standards most often included in MPCA water quality assessments are briefly discussed. Pollutants other than those mentioned here may be assessed also, as data allow.

##### a) Trace metals

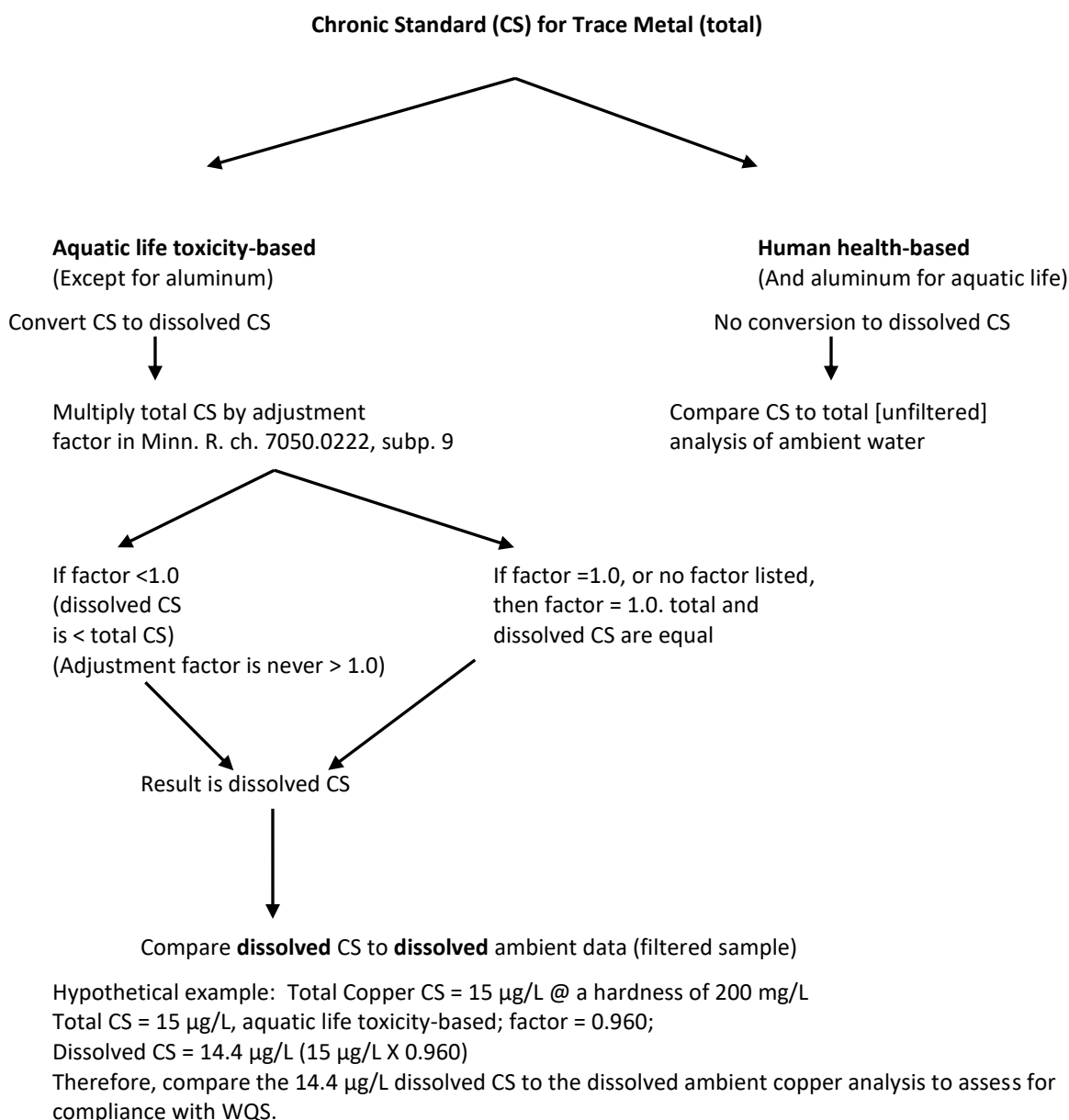
Trace metals that have chronic standards to prevent toxicity to aquatic organisms and are used in water quality assessments include aluminum, cadmium, chromium III, chromium VI, copper, lead, nickel, selenium, silver, and zinc. Antimony, arsenic, cobalt, mercury, and thallium are discussed in Chapter V because they have human health-based standards.

Minn. R. chs. 7050 and 7052 provide water quality standards (WQS) for trace metals both in terms of “total” metal and, through conversion factors, “dissolved” metal. The use of dissolved metal standards is based on evidence that the dissolved analysis is generally a better estimate of the toxic fraction of metals in most water bodies, and it is EPA policy that metal standards should be in the form of dissolved metal (EPA 1993). The exception to this is aluminum. In recent years, additional research has demonstrated that the total fraction of aluminum is a better estimate of the toxic fraction. EPA has recently updated the aluminum criteria value, and has based it on total aluminum, rather than dissolved, reflecting the updated science (EPA 2018). Total and dissolved metal data will be used in the assessments until there are adequate data to switch all lab analysis completely to dissolved metal data. However, while total metal data can be used to show that concentrations are less than and thus meet dissolved metal WQS, total metal data cannot be used to indicate impairment,

except for aluminum, as they do not provide the necessary evidence that the dissolved fraction fails to meet standards.

The chronic standards for cadmium, chromium III, copper, lead, nickel, and zinc vary with ambient total hardness. Thus, the standards for these metals are in the form of formulas that reflect the hardness/toxicity relationship. Each measured value for a hardness-dependent metal is compared to an individually calculated standard based on the hardness at near the same time and place the metal sample was taken. If the measured hardness is above 400 mg/L, a maximum hardness cap of 400 mg/L will be used to calculate the standard. If the measured hardness is below 50 mg/L, a minimum hardness cap of 50 mg/L will be used to calculate the standard.

**Figure 1. Use of trace metals data for total metals standards.**



### **b) Un-ionized ammonia**

Ammonia at elevated levels in the un-ionized form ( $\text{NH}_3$ ) is toxic to aquatic life. The chronic un-ionized ammonia standards are shown below:

- Class 2A. 0.016 mg/L un-ionized ammonia
- Class 2Bd, B, C, D. 0.04 mg/L un-ionized ammonia

The fraction of total ammonia in the un-ionized form in water is dependent on ambient pH and temperature. Therefore, pH and temperature as well as total ammonia must be measured at the same time and place to determine the un-ionized ammonia concentration.

### **c) Chloride**

Besides being a general indicator of human impacts on water quality, high levels of chloride can harm aquatic organisms, possibly by interfering with the organism's osmoregulatory capabilities. The Class 2 chronic standard for chloride is 230 mg/L.

### **d) Pesticides**

The Minnesota Department of Agriculture (MDA) conducts extensive pesticide monitoring in surface waters and submits all data to the MPCA for assessments. At present, the MPCA has Class 2 chronic and maximum aquatic life standards for acetochlor, alachlor, atrazine (including degradates), chlorpyrifos, metolachlor, and parathion.

## **2. Data requirements and determination of impaired condition**

Exceedances of standards for toxic pollutants are evaluated over consecutive three-year periods (see [Table 2](#)). Two or more exceedances of the chronic standard in three years is considered an impairment. One exceedance of the Maximum Standard is considered an impairment.

Aquatic life toxicity-based chronic WQS are written as four-day average concentrations. In some cases, pollutant concentrations can be quite variable over such periods, depending on factors such as the type and size of the water body, weather and flow conditions, and the source and nature of the pollutant. For example, chloride concentrations in lakes, streams, and wetlands are relatively stable during low flow conditions over a four-day period, while pesticide concentrations during storm events in small streams can vary greatly in that same amount of time.

Because standards are expressed as four-day averages, care must be taken to ensure that the water quality measurements used in assessments provide an adequate representation of pollutant concentrations over the relevant time period. When concentrations are judged to be relatively stable over the four-day period in question, single samples can be sufficient. When concentrations are more variable, multiple samples or time-weighted composite samples are generally necessary in order to calculate a sufficiently accurate average concentration. Flow-weighted composite samples are taken with the purpose of calculating average concentrations by volume rather than by time, and can be very difficult to interpret in assessment contexts.

If more than one sample was taken within a four-day period for flowing waters the values are averaged, (usually an arithmetic mean is appropriate) and the four-day average is counted as one value in the assessment. This includes multiple samples in four days at one



station or multiple stations along an assessment unit. For lakes, depth of sample must be taken into consideration, as concentrations may change with depth (i.e. chloride often increases with depth). Within the four-day period, samples will typically be averaged as follows: those samples collected at depths of 2 meters or less (including both grab samples and 0-2 meter integrated samples), those at depth (defined as the deepest two meters of the water column), and the mid-depth values (greater than 2 meters from the surface and the maximum depth). As with flowing waters, this averaging applies to both samples at a single station or samples collected at multiple stations along the assessment unit. Each depth will be compared against the chronic standard. If any four-day average, regardless of depth, exceeds the standard, it will count as a single exceedance for the water body (e.g. the surface average may meet the standard, while the average at 12 meters may exceed the standard – for that four-day period, a single exceedance will be counted).

The necessary number and type of samples can vary considerably from one situation to another and the determination of adequacy for the purpose of assessment will necessarily involve considerable professional judgment. It should be noted that because impairment can result from only one or two exceedances, a designation of meeting the standard generally requires extensive monitoring during times when exceedances are most likely to occur.

**Table 2. Summary of data requirements and exceedance thresholds for assessment of pollutants with aquatic life toxicity-based standards.**

Period of record	Use-support or listing category	
Most recent 10 years	No more than one exceedance of the chronic standard in three years, and no exceedances of the Maximum Standard: Not listed	Two or more exceedances of the chronic standard in three years, or one or more exceedances of the Maximum Standard: Listed

## B. Conventional pollutants and biological indicators

Conventional pollutants or water quality characteristics most often included in MPCA water quality assessments are DO, pH, temperature, sediment and river eutrophication. Sediment is measured directly through TSS concentrations or estimated from transparency tube and/or Secchi tube measurements. River eutrophication consists of a causative variable (TP) and response variables indicating eutrophication. Biological indicators (fish and invertebrates in streams and fish and plants in lakes) are currently evaluated in MPCA assessments.

Data summaries based on chemistry data and biological data are both considered, along with data quality indicators and supporting information, in aquatic life use-support determinations. Not all data types are available for all AUIDs, and not all datasets agree. The following paragraphs describe the parameter-level data that inform aquatic life use-support determinations and the process for evaluating the parameter-level and supporting data to make such decisions.

### 1. Pollutant or water quality characteristic

The conventional pollutants most often included in MPCA water quality assessments are briefly described. Pollutants other than those mentioned here may be assessed also, as data allow.

## a) Low DO

DO is required for essentially all aquatic organisms to live. When DO drops below acceptable levels, desirable aquatic organisms, such as fish, can be killed or harmed. DO standards differ depending on the use class of the water:

- Class 2A. Not less than 7 mg/L as a daily minimum
- Class 2Bd, 2B, 2C. Not less than 5 mg/L as a daily minimum
- Class 2D. Maintain background
- Class 7. Not less than 1 mg/L as a daily average, provided that measurable concentrations are present at all times

The standard for DO is expressed in terms of daily minimums and concentrations generally follow a diurnal cycle. Consequently, measurements in open-water months (April through November) should be made before 9:00 a.m.

A stream is considered to exceed the standard for DO if 1) more than 10% of the “suitable” (i.e., taken before 9:00 a.m.) May through September measurements violate the standard and there are at least three such violations, or 2) more than 10% of the total May through September measurements violate the standard and there are at least three such violations, or 3) more than 10% of the total annual measurements violate the standard and there are at least three such violations.

Because the underlying criterion is that WQS can be exceeded no more than 10% of the relevant time, it is usually essential that measurements are a representative sample of overall water quality and are not biased towards certain types of conditions, such as storm events or certain times of the year. The relevant time generally refers not to the entire year but rather to the usual water quality monitoring portion of the year. The requirement of at least three exceedances helps ensure that the measured data set is sufficiently large to provide an adequate picture of overall conditions.

In spite of the significant water quality improvements that have resulted from application of the DO standard, the current standard is not necessarily appropriate for all streams. Some low-gradient, heavily wetland-influenced streams may never meet the current DO standard of 5 mg/L, even though pollutant sources and anthropogenic influences are insignificant or even non-existent. In such cases, the current DO standard is not a useful indicator of the health of the water.

Until the DO standard is refined to fit such situations, the following will apply:

- AUIDs where all monitoring sites have wetland characteristics significant enough to preclude the use of the current DO standard as well as current biological criteria will be designated as “not assessable” for aquatic life. The following statement will be used in the documentation: *Not assessed; the waterbody exhibits prevailing wetland characteristics. Assessment is deferred pending refinement of the assessment criteria or reclassification of the waterbody.* Where appropriate, some such waters will subsequently be moved into class 2D during the use-attainability review of the watershed.
- AUIDs where all monitoring sites have wetland influences significant enough to preclude the use of the current DO standard but which are assessable using biological criteria will be designated as “not assessable” for DO. The following statement will be used in the documentation: *Not assessed for dissolved oxygen; the current standard of 5.0 mg/L is not a reliable indicator of the health*

*of this type of heavily wetland-influenced stream. Assessment for dissolved oxygen is deferred pending refinement of the assessment criteria. (Individual monitoring sites within AUIDs can likewise be determined to be not assessable for DO because of wetland influences.)*

A designation of meeting the standard for DO generally requires at least 20 suitable measurements from a set of monitoring data that give a representative, unbiased picture of DO levels over at least two different years. However, if it is determined that the data set adequately targets periods and conditions when DO exceedances are most likely to occur, a smaller number of measurements may suffice for a determination of meeting the standard.

**b) pH**

The pH of water is a measure of the degree of its acid or alkaline reaction. The applicable pH standard for most Class 2 waters is a minimum of 6.5 and a maximum of 8.5, based on the most stringent of the standards for the applicable multiple beneficial uses. pH values that are outside the range of the standard because of natural causes are not considered exceedances.

Data are compared to the pH WQS for aquatic life use, where the standard for most Class 2 waters is 6.5 – 9.0. Different pH standards for aquatic life use apply to trout streams (6.5 – 8.5). A stream is considered to exceed the standard for pH if 1) the standard is exceeded more than 10% of the days as determined from a data set that represents unbiased conditions and 2) there are at least three measurements exceeding the standard.

A stream is considered to meet the standard for pH if the standard is met at least 90% of the days of the monitoring season. A designation of meeting the standard for pH generally requires at least 20 suitable measurements from a data set that gives an unbiased representation of conditions over at least two different years.

**c) Total suspended solids (TSS)**

TSS consist of soil particles, algae, and other materials that are suspended in water and cause a lack of clarity. Excessive TSS can harm aquatic life, degrade aesthetic and recreational qualities, and make water more expensive to treat for drinking.

Transparency values, as measured by Secchi tubes (S-tube), reliably predict TSS and can serve as surrogates. While TSS measurements themselves are generally preferred, datasets for S-tube are often more robust, and their relative strength will be considered in assessments.

Because S-tube measurements are not perfect surrogates, however, their use involves a margin of safety. Therefore, the S-tube surrogate thresholds for determining if a stream exceeds the TSS standard are different than for determining if a stream meets the standard.

**Table 3. Minnesota’s TSS (mg/L), S-tube (cm) and site-specific standards for specifically named river reaches.**

Region or River	TSS	S-tube Exceeds	S-tube Meets
All Class 2A Waters	10	55	95
Northern River Nutrient Region as Modified for TSS	15	40	55
Central River Nutrient Region as Modified for TSS	30	25	35
Southern River Nutrient Region as Modified for TSS	65	10	15
Red River Mainstem – Headwaters to Border	100	5	10
<i>(Assessment season for above waters is April through September)</i>			
Lower Mississippi River Mainstem – Pools 2 through 4	32		
Lower Mississippi River Mainstem below Lake Pepin	30		
<i>(Assessment season for Lower Mississippi is June through September)</i>			

Details regarding RNR boundaries and assignments as adapted for application of the Minnesota TSS water quality standards can be found in Heiskary and Parson (2013) at <https://www.pca.state.mn.us/sites/default/files/wq-s6-18.pdf>, including a statewide map in [Figure 4](#).

A stream is considered to exceed the standard for TSS/S-tube if 1) the standard is exceeded more than 10% of the days of the assessment season (April through September) as determined from a data set that gives an unbiased representation of conditions over the assessment season, and 2) there are at least three such measurements exceeding the standard. The Lower Mississippi River is considered to exceed the standard for TSS if summer (June through September) average concentrations exceed the standard in more than half of the summers.

A stream is considered to meet the standard for TSS/S-tube if the standard is met at least 90% of the days of the assessment season. A designation of meeting the standard for TSS/S-tube generally requires at least 20 suitable measurements from a data set that gives an unbiased representation of conditions over at least two different years. However, if it is determined that the data set adequately targets periods and conditions when exceedances are most likely to occur, a smaller number of measurements may suffice. The Lower Mississippi River is considered to meet the standard for TSS if summer average concentrations do not exceed the standard in more than half of the summers.

S-tube measurements that fall between the two relevant surrogate values are considered to be indeterminate in exceeding or meeting the TSS standard. If a stream satisfies neither the criterion for exceeding the standard nor the criterion for meeting the standard, the stream is considered to have insufficient information regarding TSS levels.

#### **d) Temperature**

High water temperatures, or rapid elevations of temperature above ambient, can be very detrimental to fish. Cold water fish such as trout are particularly intolerant of high temperatures. The temperature standard for Class 2A cold water sport fish is a narrative statement of “no material increase.” A demonstration of a “material increase” means that temperature data must show a statistically significant increase when measured, for example, upstream and downstream of a stream modification, upstream and downstream of a point or nonpoint heat source, or before and after a modification that

might impact stream temperature. Temperatures must be for similar time frames such as weeks or seasons. The larger the data set, the finer the precision in determining whether a material increase in stream temperature has occurred.

Currently the MPCA is evaluating mostly cold water fisheries for temperature-caused impairment because of the special sensitivity of cold water fish to elevations in temperature in streams.

**e) Biological indicators**

The presence of a healthy, diverse, and reproducing aquatic community is a good indication that the aquatic life beneficial use is being supported by a lake, stream, or wetland. The aquatic community integrates the cumulative impacts of pollutants, habitat alteration, and hydrologic modification on a water body over time. Monitoring the aquatic community, or biological monitoring, is therefore a relatively direct way to assess aquatic life use-support. Interpreting aquatic community data is accomplished using an index of biological integrity or IBI. The IBI incorporates multiple attributes of the aquatic community, called “metrics,” to evaluate a complex biological system. MPCA has developed fish and invertebrate IBIs to assess the aquatic life use of rivers and streams statewide in Minnesota as well as plant and invertebrate IBIs to assess depressional wetlands. A fish IBI has been developed by the DNR with assistance from MPCA to assess the aquatic life use of several lake types. A predictive model based plant indicator also developed by DNR as a measure of eutrophication stress to lake plant communities was used as supporting information only. For more information on lake IBIs, see [http://www.dnr.state.mn.us/waters/surfacewater\\_section/lake\\_ibi/index.html](http://www.dnr.state.mn.us/waters/surfacewater_section/lake_ibi/index.html).

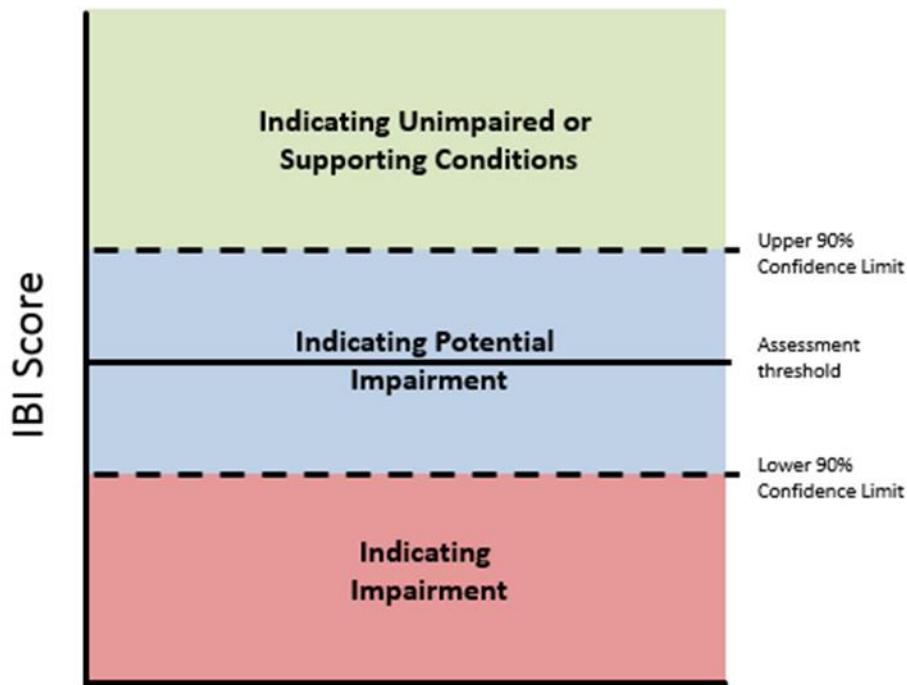
Further interpretation of aquatic community data is provided by an assessment threshold or biocriteria against which an IBI score can be compared. In general, an IBI score above this threshold is indicative of aquatic life use-support, while a score below the threshold is indicative of non-support. Currently, Minnesota is using a combination of two similar concepts to set biocriteria: the Biological Condition Gradient (BCG) and reference condition. To develop biocriteria that are protective of the structural and functional health of biological communities, Minnesota used the median of BCG level 4. Communities at the middle of this level can be best characterized as possessing “overall balanced distribution of all expected major groups; ecosystem functions largely maintained through redundant attributes” which is in line with the language of the CWA interim goal. This BCG-derived criteria was then compared to criteria derived from reference sites to insure that the two approaches were closely aligned in each IBI class. This same BCG process was used to set the threshold for the lake fish IBI classes.

Minnesota adopted Tiered Aquatic Life Uses (TALU) in 2018. This framework refines Minnesota’s single goal for aquatic life into three tiers that are based on the aquatic life potential for a water body. These tiered uses are Exceptional, General (current goal), and Modified. The process for determining the appropriate tier is called a Use Attainability Analysis (see <http://www.pca.state.mn.us/index.php/view-document.html?gid=23281>) and it is carried out before the assessment process. The actual mechanisms for performing an assessment of TALUs are similar to the current process with the only major difference being the biocriteria threshold (Table 12).

Bracketing each IBI assessment threshold is a 90% confidence interval that is based on the variability of IBI scores obtained at sites sampled multiple times in the same year (i.e., replicates). Confidence intervals account for variability due to natural temporal changes in the community as well as method error. For assessment purposes, sites with IBI scores within the 90% confidence interval are considered “potentially impaired.” Upon further review of available supporting information, an IBI parameter review may change to “indicating support” or “indicating impairment” depending on the extent and nature of this additional information ([Figure 2](#)).

See Appendix F for further information regarding the basis of biological assessments including Minnesota’s WQS, the development of the BCG, the selection of river and stream reference sites, and the development and the application of the IBI for lakes.

**Figure 2. General diagram illustrating the characterization of individual biological indicator results.**



#### f) River eutrophication

The River Eutrophication Standard (RES) is a two-part standard, requiring an exceedance of the causative variable (TP) and a response variable which indicates the presence of eutrophication (i.e. undesirable levels of sestonic or suspended algae, benthic or attached algae, or excessive rooted vegetation). This response can be measured directly with sestonic chlorophyll-*a* or indirectly via DO flux, five-day biochemical oxygen demand (BOD<sub>5</sub>) or pH. These measures are highly correlated with each other in rivers and are indicators of stress for aquatic communities.

The first step in applying Minnesota’s RES is to determine the appropriate River Nutrient Region (RNR), or regions, for the water body being assessed. (Site-specific navigational pool and Lake Pepin standards do not require this step.) There are 80 eight-digit Hydrological Unit Code (HUC-8) watersheds in Minnesota. These were overlaid with the EPA Level III ecoregion map to develop the RNRs. River eutrophication standards vary by RNR and can be found in [Table 4](#).

**Table 4. Minnesota’s River eutrophication and site-specific standards for navigational pools, Lake Pepin and specifically named river reaches.**

Region or river	Causative	Response (stress)		
	Total phosphorus (ug/L)	Chlorophyll- <i>a</i> (ug/L)	Diel dissolved oxygen flux (mg/L)	Biological oxygen demand (mg/L)
Northern River Nutrient Region	50	7	3.0	1.5
Central River Nutrient Region	100	18	3.5	2.0
Southern River Nutrient Region	150	40	5.0	3.5
Site-Specific Standards				
Mississippi River Navigational Pool 1	100	35		
Mississippi River Navigational Pool 2	125	35		
Mississippi River Navigational Pool 3	100	35		
Lake Pepin (Mississippi River Navigational Pool 4)	100	28		
Mississippi River Navigational Pools 5 to 8	100	35		
Crow Wing River from Long Prairie River to the Mouth of the Crow Wing River	75	13	3.5	1.7
Crow River from the confluence of the North Fork and South Fork of the Crow River to the mouth of the Crow River	125	27	4.0	2.5

For assessment purposes this means the cause indicator (phosphorus) and response indicators (chl-*a*, BOD<sub>5</sub>, diel DO flux, or pH) are used in combination and not independently. The eutrophication rule clearly states the requirement that cause and response indicators must both be exceeded to indicate a polluted condition.

#### **Data minimums and summarizations**

For TP, chlorophyll-*a*, and BOD<sub>5</sub>, the following are required:

- A minimum of 12 measurements per parameter within the 10-year assessment period (minimum 2 years required)
- Data compared to the standard is a seasonal average – June to September data only
- If multiple values exist for a parameter along a given reach for a single day, a daily average will be calculated prior to determining a seasonal average

For DO flux

- A minimum of a 4-day deployment is required – June to September
- A minimum of two deployments over separate years in the assessment window is required.
- It is preferred that the deployments coincide with summers when chemistry is collected and that the deployment is taken during mid-late summer
- Multiple deployments will be summarized separately

For pH

- Class 2A waters: pH range is  $6.5 \leq \text{concentration} \leq 8.5$
- Classes 2B and 2Bd waters: pH range is  $6.5 \leq \text{concentration} \leq 9.0$

- Minimum of 20 samples necessary to indicate standard is met
- Review of data is limited to June to September

#### Assessment considerations

A stream is considered to exceed the river eutrophication standard if:

- The total phosphorus (TP) concentration exceeds the standard
- Chlorophyll-*a*, BOD<sub>5</sub>, DO Flux, OR pH exceeds the standard.

A stream is considered to meet the river eutrophication standard if:

1. The TP concentration meets the standard.
2. TP meets the standard and any available response variables meet the standard (this includes the situation where no response variables are present). Not all response variables must be available to consider the reach to be meeting the river eutrophication standard.
3. TP exceeds the standard **and** all response variables are available in sufficient quantities (chl-*a*, BOD<sub>5</sub>, DO Flux, pH) and they all meet the standard.

A stream is considered to have insufficient information if:

1. There are less than 12 samples of the causative variable (TP).
2. There is sufficient TP, it exceeds the standard **and** no response variables meet the minimum data requirements.
3. The causative and/or response variables are within the standard error of the mean and confidence does not exist in determining whether the reach meets or exceeds the standard.
4. The causative and/or response variables have low data confidence or are not representative of ambient conditions (poor QA/QC, flood or drought biased sampling, proximity to continuously discharging facilities, etc.).

Due to the complexity of the standard, additional information to aid an assessment decision is available in Appendix G.

## 2. Data requirements and determination of impaired condition

Overall assessment of whether an AUID adequately supports aquatic life involves the review of the parameter-level evaluations and data quality in conjunction with all available supporting information (flow/water level, habitat, precipitation, plant surveys, etc.) to make an overall use-support determination. For a given AUID, there may be chemistry indicator data, biological indicator data, or both types of data available for assessment. The final assessment takes into consideration the strength of the various indicators and the quality of the data sets and, in addition, looks at upstream and downstream conditions to gain a better understanding of the interactions between the individual AUID and the larger water body and watershed.

In general:

- A stream reach or lake is considered to be **fully supporting** of aquatic life if:
  - IBI scores for all available assemblages indicate fully supporting conditions
  - The standards for river eutrophication and/or DO are met and TSS/Secchi tube are met (streams only)



- Other lines of evidence considered comprehensively, including upstream/downstream conditions, do not contradict a finding of full support
- A stream reach or lake is considered to be **not supporting** if:
  - IBI scores for at least one biological assemblage indicate impairment
  - One or more water chemistry parameters indicates impairment
  - Other lines of evidence considered comprehensively, including upstream/downstream conditions, do not contradict a finding of non-support
- If the above criteria are not met and the assessment is inconclusive, the result is a determination of **insufficient information**.

In cases where an assessment unit has been determined to be not supporting based on biological indicators, water-chemistry parameters are added to the list of impairments only when the chemical impairment is clear enough that the AUID would be considered impaired even without the biological evidence.

The following paragraphs provide more details of the considerations that occur when analyzing the available data and information to make a comprehensive aquatic life use-support assessment, based on what types of indicator data are available. This information is used by the WAT and PJG for each watershed as guidance in making use-support decisions.

#### **a) Only biological indicator data available**

*Fully Supporting* – All **available** fish and invertebrate IBI scores within the assessment unit fall above the upper 90% confidence limit. A fully supporting determination does not require that both indicator assemblages have been measured within the assessment unit.

*Not Supporting* – All fish and/or invertebrate IBI scores fall below the lower 90% confidence limit. A not supporting determination does not require agreement between the indicator assemblages; one assemblage indicating impairment is sufficient for a not supporting determination.

Otherwise, initial assessment is potentially impaired when one or more IBI scores fall within the 90% confidence interval that bounds the assessment threshold **or** multiple IBI scores within an indicator assemblage are resulting in discrepant assessments. Further analysis is required to make a use-support determination, consider the following factors:

- Co-occurrence of indicator data
- Habitat conditions
- Sampling conditions
- Watershed context

#### **b) Only water chemistry indicator data available**

*Fully Supporting (streams only)* – 1) The standards for river eutrophication and/or DO are met, AND TSS/Secchi Tube are met for streams, AND 2) supporting information including upstream/downstream conditions, do not strongly contradict a finding of full support. In making this determination, consider the following factors:

- Co-occurrence of indicator data
- Strength of indicator
- Parameter-level evaluations

- Sampling conditions
- Watershed context
- Continuous monitoring data (when available)

*Not Supporting (streams or lakes)* – 1) One or more water chemistry parameters indicate potential impairment or impairment **and** 2) supporting information including upstream/downstream conditions do not strongly contradict a finding of non-support. If the first condition is met, condition two should primarily be evaluated considering:

- Strength of indicator
- Parameter-level evaluations
- Watershed context
- Continuous monitoring data (when available)

In general, information from within the assessment unit (strength of indicator and parameter-level evaluation) serves as the primary arbiter for making a not supporting determination, while assessments and data from adjacent assessment units (watershed context) provides additional information that either corroborates or refutes this determination. Considering these three factors together, a **not supporting** determination is more likely in situations where

- 1) Parameter-level evaluations indicate potential impairment or impairment, 2) the strength of these indicators is medium or high, **and** 3) the assessment is corroborated by similar conditions upstream or downstream of the assessment unit in question. Continuous monitoring data, if available, can be used to either corroborate or refute the evidence provided by grab-sample data sets.

#### c) **Both biological and water chemistry indicator data**

*Fully Supporting* – 1) IBI score for at least one biological assemblage indicates supporting conditions OR the standards for river eutrophication and/or DO are met, and TSS/Secchi tube are met (streams only), **and** 2) other data and information considered comprehensively, including upstream/downstream conditions, do not strongly contradict a finding of full support. If the first condition is met, condition two should be evaluated considering the following factors:

- Co-occurrence of indicator data
- Strength of indicator
- Parameter-level evaluations
- Habitat conditions
- Sampling conditions
- Watershed context
- Continuous monitoring data (when available)

*Not Supporting* – 1) IBI score for at least one biological assemblage indicates impairment OR 2) IBI score for at least one biological assemblage indicates potential impairment **and** the parameter-level evaluations and other data and information considered comprehensively corroborate a finding of non-support OR 3) one or more water chemistry parameters indicate impairment **and** the evidence considered comprehensively leads to a conclusion of non-support. To evaluate all three conditions, consider the following factors:

- Co-occurrence of indicator data
- Strength of indicator
- Parameter-level evaluations
- Habitat conditions
- Sampling conditions
- Watershed context
- Continuous monitoring data (when available)

**d) Insufficient information**

If the criteria are not met for a fully supporting or not supporting assessment and the assessment is inconclusive, the result is a determination of insufficient information.

“Insufficient information” determinations include situations where sufficient data are not available to assess the use, or the strength of the available indicator(s) is low and there is no supporting information available to help verify what the weak dataset is indicating. Sites receiving an “insufficient information” assessment may be prioritized for follow-up monitoring during MPCA stressor identification efforts, addressed by local monitoring efforts, or monitored further during the next round of IWM.

## VI. Aquatic consumption and drinking water

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This section focuses on Human Health-based Water Quality Standards (HH-WQS): Class 2 chronic standards (CSs) and site-specific chronic criteria (CC). These standards serve as the basis for developing chronic or long-term protection for humans from toxic pollutants to ensure the beneficial uses of drinking water (where designated) and fish consumption and recreation in all surface waters are met. Class 2 numeric WQS and criteria for human health cover elemental and synthetic chemical contaminants characterized as toxic pollutants<sup>1</sup>.

The Class 1 designation and associated domestic consumption (DC) standards specifically address drinking water and food processing use of groundwater and designated surface waters. The Federal Safe Drinking Water Act standards incorporated by reference into Minn. R. ch. 7050 provide the numeric basis for protecting this use. Application of Class 1 DC standards for nitrate and nitrite in surface waters designated for drinking water protection is also discussed in this section.

### A. Pollutants with Class 2 human health-based chronic standards

Class 2 chronic standards (CS) to protect human health are developed for application in water, as described in the previous chapter, and in fish tissue. For toxic pollutants detected in surface water that lack CSs, the methods in Minn. R. chs. 7050 and 7052 are used to develop site-specific CC. Fish tissue-based CSs (or CC) are described later in this section. Full details on HH-WQS are found in Minn. R. chs. 7050 and 7052 and in the *Human Health-based Water Quality Standards Technical Support Document* (September 2015), available at <https://www.pca.state.mn.us/sites/default/files/wq-s6-12.pdf>.

#### 1. Algorithms for human health-based chronic standards

HH-WQS are set at concentrations to protect human users of surface waters. That protection considers the toxicity (deleterious, noxious, or injurious) characteristics of the pollutant and how much a population may be exposed to that pollutant through the three designated beneficial uses of surface waters: drinking water, recreational activities, and fish consumption. In short, HH-WQS encompass a pollutant's toxicity and a population's potential exposure and lead to numeric CSs (or site-specific CC) that cannot be exceeded in surface water or fish tissue.

The methods used to develop pollutant-specific numeric HH-WQS (Class 2 CSs or CC) for toxic pollutants were first adopted in 1990 for statewide application and in 1998 for the Lake Superior Basin. Currently, Minn. R. ch. 7050 contains Class 2 standards for 69 toxic pollutants. Of these, 36 standards are more restrictive to protect human health than aquatic life (Minn. R. 7050.0222). Minn. R. ch. 7052 contains Class 2 standards for 29 pollutants; for 15 of these standards human health is the basis for the most stringent CS (Minn. R. 7052.0100).

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<sup>1</sup> Minn. Statute 115: Toxic Pollutant: means those pollutants, or combinations of pollutants, including disease-causing agents, which after discharge and upon exposure, ingestion, inhalation or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will, on the basis of information available to the agency, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, including malfunctions in reproduction, or physical deformation, in such organisms or their offspring.

## 2. Pollutants with human health-based chronic standards

The pollutants that have human health-based CSs that are most often included in MPCA water quality assessments are briefly described. Pollutants other than those mentioned here may be assessed also, as data allow.

### a) Trace metals

Trace metals with chronic standards to protect human health include antimony, arsenic, cobalt, mercury, and thallium. Mercury is discussed in the next section. Minn. R. chs 7050 and 7052 provide human health-based CSs for trace metals. To determine if human health-based CSs are being met, data with the total sample fraction is used. Both dissolved and total metals measurements can be used to determine impairment, but dissolved metals data cannot be used to determine if standards are met. See also [Figure 1](#).

### b) Mercury

Mercury is the classic example of a bioaccumulative element; it never degrades, it can bioaccumulate through the food chain to reach toxic levels in many fish species, which if eaten in high amounts, can lead to serious health effects. Neurodevelopmental effects to children exposed during gestation are of most concern. Because mercury primarily enters water from air sources (local to global), full control of sources is not possible; therefore, the Minnesota Department of Health (MDH) Fish Consumption Advice is an important means for addressing the ongoing presence of mercury in fish and providing guidance to fish consumers to keep exposure from mercury and other bioaccumulative pollutants in fish low (discussed further in the fish pollutant section).

Mercury CSs are based on total concentrations and, thus, total mercury measurements are used in assessments. Minnesota has two water-column Class 2 WQS for total mercury, as shown below (although the more stringent CS for Lake Superior is based on fish-eating wildlife, this value is protective of human consumers and assessed the same way as the statewide mercury CS).

- 6.9 ng/L. chronic standard, Minn. R. ch. 7050.0222 (statewide)
- 1.3 ng/L. chronic standard, Minn. R. ch. 7052.0100 (waters of Lake Superior Basin)

In 2008, MPCA also adopted a fish tissue mercury standard into Minn. R. ch. 7050.

- 0.2 mg/kg, total in edible fish tissue

### c) Pesticides

The MDA conducts extensive pesticide monitoring in surface waters and submits all data to the MPCA for assessments. At present, the MPCA has human health-based chronic standards for alachlor, atrazine (including degradates), 2,4-D, 2,4,5-TP, carbofuran, glyphosate, methoxychlor, picloram and simazine.

### 3. Data requirements and determination of impaired condition

The requirements for assessing water bodies for exceedances of human health-based CSs and human health- and aquatic life toxicity-based CSs are essentially the same as for chemicals with aquatic life toxicity-based standards (see Section V. A.) The major difference is that data compared to the human health-based CSs are averaged over a 30-day period.

**Table 5. Summary of data requirements and exceedance thresholds for assessment of pollutants with human health-based, human health- and aquatic life toxicity-based, and wildlife-based standards.**

Period of record	Use-support or listing category	
Most recent 10 years	No more than 1 exceedance of the chronic standard in 3 years, and no exceedances of the Maximum Standard: Not listed	2 or more exceedances of the chronic standard in 3 years, or 1 or more exceedances of the Maximum Standard: Listed

## B. Protection for human consumption of fish

This section describes the assessment of fish for human consumption based on fish contaminant data. The MPCA now has methods to develop fish tissue CSs (or CC) that will be the basis of determining if pollutants in fish fillets exceed HH-WQS. The application of MDH Fish Consumption Advice (FCA) thresholds for evaluating impairments will be limited as described in this section. Most fish monitoring data will continue to be collected through the interagency Fish Contaminant Monitoring Program (FCMP) and also used by MDH for FCA. See Minn. R. 7050.0219, <https://www.revisor.mn.gov/rules/?id=7050.0219>, for details.

### 1. Basis for assessment of fish contaminants

The basis for assessing the contaminants in fish tissue is the narrative WQS and assessment factors in Minn. R. ch. 7050.0150, subp. 7, which states the following:

*Subp. 7. Impairment of waters relating to fish for human consumption.*

*A. In evaluating whether the narrative standards in subpart 3, which prevent harmful pesticide or other toxic pollutant residues in aquatic flora or fauna, are being met, the commissioner must use the methods in:*

*(1) parts 7050.0218 and 7050.0219 for site-specific fish tissue-based chronic criterion ( $CC_{ft}$ ); or*

*(2) parts 7050.0222 and 7052.0100 for fish tissue-based chronic standard ( $CS_{ft}$ ).*

*B. If  $CS_{ft}$  has not been established for a pollutant with chronic standards (CS) applicable in water ( $CS_{dfr}$ ,  $CS_{dev}$ , or  $CS_{fr}$ , as defined in parts 7050.0218, subpart 3, item Q, and 7050.0219, subpart 13, item B), the residue levels in fish muscle tissue established by the Minnesota Department of Health must be used to identify surface waters supporting fish for which the Minnesota Department of Health recommends a reduced frequency of fish consumption for the protection of public health. A water body will be considered impaired when the recommended consumption frequency is less than one meal per week, such as one meal per month, for any member of the population. That is, a water body will not be considered impaired if the recommended consumption frequency is one meal per week, or any less restrictive recommendation such as two meals per week, for all members of the*

population. The impaired condition must be supported with measured data on the contaminant levels in the resident fish.

C. When making impairment determinations in an individual water body for a pollutant with both a fish tissue-based  $CC_{ft}$  or  $CS_{ft}$  and a CS applicable in water, comparison of fish tissue data to the  $CC_{ft}$  or  $CS_{ft}$  must be the basis for the final impairment determination.

## 2. MPCA assessment of pollutants in fish tissue

Chemicals that persist in the environment and “build up” in the tissues of aquatic organisms to higher concentrations than the concentrations in the surrounding water are called bioaccumulative chemicals of concern (BCCs). Uptake through the food chain means that at each step, from plants to prey to predator, the concentrations in the biota increase. This “biomagnification” as it is called is a concern because many game fish (e.g., walleye, northern pike, bass, and lake trout) are at the top of the aquatic food chain and typically carry the highest tissue concentrations of a BCC in the aquatic system.

The bioaccumulation factor (BAF) is the ratio between the concentration of the chemical in the biota and the concentration of the chemical in the water. BAFs can exceed one million for very highly bioaccumulative chemicals. A BAF must be determined to calculate a human health-based water column standard. For pollutants defined as BCCs, BAFs > 1000, the CSs are very low water column concentrations in order to limit their concentration in fish tissue. For these chemicals, such as mercury, polychlorinated biphenyls (PCBs), and dioxins, exposure from the fish consumption pathway also far exceeds that from drinking water or recreational activities.

The MDH has had a long-standing public outreach program, FCA, to support the continued good health of people that eat fish in Minnesota. The MDH issues guidelines for how often certain fish can be eaten. The FCA addresses mercury, PCBs, and perfluorooctane sulfonate (PFOS) using concentrations in fish tissue that corresponds to meal frequency recommendations (Table 6). The advice also identifies water bodies with fish showing elevated levels of dioxins and furans. As an advisory, the goal of the FCA is to help people make informed decisions on which fish to eat and which to avoid. The advice is not mandatory nor regulatory.

**Table 6. Fish tissue concentrations for levels of consumption advice established by MDH (April 2008)**

Consumption Advice	Unrestricted	One Meal per Week	One Meal per month	One Meal per Two Months	Do Not Eat
*Mercury (mg/kg)	≤ 0.05	>0.05 - 0.22	>0.22 - 0.95		> 0.95
Total PCBs (mg/kg)	≤ 0.05	>0.05 - 0.22	>0.22 - 0.95	>0.95 - 1.89	> 1.89
PFOS (mg/kg)	≤ 0.040	>0.04 – 0.20	>0.20 – 0.80		> 0.80

\* Consumption advice for young children and women who are pregnant or may become pregnant:  
<https://www.health.state.mn.us/communities/environment/fish/>.

The MPCA has now adopted methods to develop fish tissue standards or site-specific criteria for these and any other BCC identified in or with the potential to be present in fish.

**a) Mercury**

Mercury is a BCC detected in most fish. Concentrations reach levels of concern in many predator species. Based on EPA guidance, MPCA adopted a fish tissue standard for mercury in 2008 to provide a more accurate and directly usable standard to protect fish consumers.

The fish tissue-based  $CS_{ft}$  for total mercury is found in Minn. R. 7050.0222. It is applicable in all Class 2 surface waters.

- 0.2 mg/kg in edible fish tissue (statewide)

**b) Polychlorinated biphenyls (PCBs)**

PCBs constitute a group of chlorinated organic compounds distributed worldwide. Their extensive historical use combined with their persistence, bioaccumulative properties, and cancer and non-cancer toxicity, make them very serious environmental pollutants. Concentrations of PCBs in water are very low (typically less than one part per trillion) and difficult to measure. However, because they bioaccumulate as much as a million fold or more in fish, they are readily measured in fish tissues. Thus, PCBs are usually assessed for the 303(d) List on the basis of their presence in fish, resulting in MDH advice to anglers to limit their consumption of certain fish. MDH FCA thresholds will continue to be used for PCBs as water CSs exist in rule and  $CS_{ft}$  in fish tissue will need to be adopted, along with revised CSs in water, in a future rulemaking.

Previous and ongoing assessments of PCBs in fish tissue will use the FCA concentration that restricts fish consumption from one meal a week to one meal a month, 0.22 mg/kg, for determining if the fish meet the protection level goals for fish consumers. Concentrations above this amount identified as advisory levels for any fish species in a water body result in that water body being listed as impaired for PCBs.

**c) Perfluorooctane Sulfonate (PFOS)**

PFOS is a synthetic perfluorinated chemical used for decades to make products that resist heat, oil, stains, grease, and water. The MPCA has been monitoring for PFOS in fish since 2004 and has identified certain waters as impaired due to concentrations in fillets exceeding 0.20 mg/kg. This is the concentration used in FCA to restrict fish consumption from one meal a week to one meal a month. With the adoption of the revised methods for HH-WQS, future assessments will be based on the new methods for developing fish-tissue based chronic criteria (CC) or standards in Minn. R. 7050.0217 to 7050.0219. MDH FCA will not be the basis for assessments.

**d) Dioxins and Furans**

Dioxins and furans are similar to PCBs in many respects. Both represent a family of chlorinated organic chemicals, some of which are very persistent, bioaccumulative and toxic, as well as global in their distribution. Unlike PCBs, dioxins and furans were never intentionally manufactured. The major sources are combustion of waste, plastics, and wood, chlorine bleaching of pulpwood (now largely phased out), and trace contaminants in other manufactured organic compounds. 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) has been shown to be carcinogenic in animals at extremely low doses. The MPCA has Class 2 HH-WQS for 2,3,7,8-TCDD in Minn. R. ch. 7052, applicable only to waters in the Lake Superior basin. These standards also include other dioxins and furans



with toxic equivalent factors. Some PCB congeners can also have dioxin-like toxicity and considered when data are available. The only 2,3,7,8-TCDD standard in Minn. R. ch. 7050 is the EPA drinking water standard of 30 pg/L.

The MPCA evaluates waters for dioxins and furans only at site-specific locations where contamination is suspected or where data are needed to support remedial efforts. Evaluation of dioxin and furans in fish tissue will be based on site-specific CC or standards developed based on Minn. R. 7050.0217 to 7050.0219 and Minn. R. 7052.0270.

### 3. Data requirements and determination of impaired condition

The 303(d) Impaired Waters List identifies water bodies that do not meet legally enforceable water quality standards (WQS) or site-specific criteria, and for which a remedial plan may be required. An important caveat is that one cannot assume, because a particular water body does not appear on the 303(d) List, the fish in that water body are safe for unlimited consumption. Most likely, it means the fish from that water body have not been tested. Only those water bodies from which the fish have been tested and found to exceed the impairment thresholds will be put on the 303(d) List. In addition, water bodies listed as impaired for fish consumption can still yield fish low in pollutant concentrations. The MDH FCA should be consulted for advice on fish consumption and health risks on a statewide or water body basis (MDH 2001).

The MDH currently relies on a regression approach to determine consumption advice for variable size ranges. The advisory threshold concentrations summarized in [Table 6](#) are applied to the most recent 10 years of data from a water body. Impairments for PCBs are based on a fish tissue concentration exceeding 0.22 mg/kg, which is the upper threshold for one meal per week fish consumption.

For pollutant data in fish, other than PCBs, the determination of impaired waters for fish consumption reflects approaches used to assess water quality data. The 0.2 mg/kg fish mercury concentration is the threshold for determining impairment for total mercury in edible fish tissue<sup>2</sup>.

For other fish pollutants, the MPCA would develop site-specific  $CC_{ft}$  or future  $CS_{ft}$  to assess fish for impairment.

A water body is defined as impaired based on two approaches depending on the number of fish and species with available monitoring data.

#### a) Multiple fish of one species:

If more than 10% of the fish (minimum of five fish) in a species are greater than the fish tissue-based  $CS_{ft}$  or  $CC_{ft}$ , the fish are not meeting the WQS. This is equivalent to saying the water is impaired if the 90th percentile of the pollutant concentration for any fish species is greater than the  $CS_{ft}$  or  $CC_{ft}$ . This is the same protocol that has been used to assess mercury in fish.

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<sup>2</sup> Note: The Statewide Mercury TMDL does not apply to waters with measured fish tissue mercury concentrations greater than 0.57 mg/kg. These waters remain as Category 5 waters on the MPCA 303(d) list.

To determine which water bodies (lake, reservoir, or stream assessment unit) are impaired for fish consumption, the Minnesota FCMP database is queried for the following criteria:

- Fish collected in the last 10 years, unless the 90th percentile between years 10 to 6 and years 5 to present are statistically different, in which case only the most recent 5 years is used in the assessment.
- Filet with or without skin on; no whole fish.
- At least five fish in a species, including fish within a composite sample, is needed for 90<sup>th</sup> percentile calculation.
- 90th percentile fish tissue concentration is greater than  $CS_{ft}$  or  $CC_{ft}$  (i.e., more than 10% are greater than  $CS_{ft}$  or  $CC_{ft}$ ).

The 90th percentile rank is calculated by multiplying the number of fish by 0.9 and rounding to the nearest whole number. The 90th percentile pollutant concentration is determined for each water body-species by (1) ranking the samples within each water body-species from low to high, (2) concentration of a composite sample is treated as the concentration for all fish within the composite, (3) if the 90th percentile ranked fish is greater than  $CS_{ft}$  or  $CC_{ft}$  or is in a composite that is greater than  $CS_{ft}$  or  $CC_{ft}$ , it is marked as impaired.

**b) Fewer fish of more than one species:**

If a water body has multiple species of fish with pollutant monitoring data, but fewer than five fish per species, the alternate method for determining if WQS are being met is through averaging a concentration across species. In a weight-of-evidence approach, if the average concentration of at least three species exceeds the  $CS_{ft}$  or  $CC_{ft}$  that water body would also be identified as impaired. Like the evaluation for multiple fish of one species, fish collected in the last 10 years would be used unless enough fish samples are available to compare average concentrations between years 10 and 6 and 5 to present. If the averages are statistically different then only the most recent 5 years is used in the assessment.

Both scenarios recognize that concentrations in fish are a result of a longer-term average exposure and that the fish sampled by the FCMP focus on those species regularly caught and consumed by Minnesotans; reasonable evidence of fish with pollutant concentrations above  $CS_{ft}$  or  $CC_{ft}$  warrants concern and impairment designation. Based on the FCMP sampling protocol, most water bodies monitored will exceed the minimum data requirements or include the species of most concern for the respective pollutant (i.e., walleye for mercury or bottom feeders, such as carp or catfish, for PCBs).

With the revised HH-WQS methods, fish data for BCCs is the basis for impairment determination if water data are also available (Minn. R. 7050.0222, subp. 7, item C.).

## C. Additional guidance for assessing human health-based standards

### 1. Chemical breakdown products or environmental degradates

Some pollutants, when introduced into the environment, undergo chemical transformation through microbial, photolysis, or other processes. Particularly for pesticides, there are known common environmental breakdown products referred to as degradates that originate from the “parent” chemical. In order to be health protective, breakdown chemicals that originate from a “parent” chemical should be assessed the same as the “parent” when toxicological data on the degrade are insufficient for a chemical-specific health based water value. To address degradates found in surface water, the MPCA applies the parent HH-WQS to environmental degradates or MDH health-based guidance when available (Minn. R. ch. 7050.0222, subp. 7, item D).

### 2. Mixtures of pollutants in a water or fish sample

Another aspect to assessing Class 2 CSs (and CC) based on human health is the presence of more than one toxic pollutant in a sample. This is dependent on the toxicity determination of each pollutant: carcinogen, denoted with a “(c)” next to the pollutant’s name in Minn. R. 7050.0220 or 7050.0222, or noncarcinogen.

For linear carcinogens, the additivity algorithm is as listed in Minn. R. 7050.0222, subp. 7 item E, and Minn. R. 7052.0230, subp. 2. The additivity equation applies to chemicals that are linear carcinogens and have HH-WQS calculated with a cancer slope factor. A risk index is calculated for each carcinogen in the sample by dividing the concentration of the pollutant by its CS (or CC) and summing those values. The risk index value has to be equal to or less than one to meet HH-WQS. An index that exceeds one indicates the excess cancer risk level is greater than 1 in 100,000 and is in violation of the HH-WQS.

The MPCA recently added to this existing protection to surface water users by including a new approach for noncancer mixtures: an additivity analysis modeled on the MDH Health Risk Limit rule. The approach is again based on summing up the ratio of each pollutant concentration measured in the surface water or in fish tissue to their respective CS (or CC) based on their *Health Endpoint*. To ensure total exposure does not exceed the threshold for noncancer effects in the target organ, system, or process (development), the sum or *Health Risk Index* has to equal one or less to meet the HH-WQS.

Health Risk Index Endpoints (*Health Endpoints*) will be incorporated into HH-WQS for evaluation of mixtures of noncarcinogens. The MDH lists *Health Endpoints* for each noncarcinogen (or nonlinear carcinogen) unless the available study used to develop the toxicological values (reference dose) did not identify a specific adverse effect. *Health Endpoints* identify the most sensitive target organs or systems (e.g., nervous) or developmental process affected by that pollutant. These endpoints are used to group chemicals to evaluate mixtures if more than one pollutant with the same adverse effect is measured in a fish sample or water body. The details of this evaluation are in Minn. R. 7050.0222, subp. 7, item D.

## D. Class 1 drinking water standards for nitrate nitrogen

Class 1 waters are protected as a source of drinking water. In Minnesota, all groundwater and selected surface waters are designated Class 1. The assessment of groundwater (Class 1A) for potential impairment of the drinking water use is outside the scope of this Guidance. The MDH monitors municipal finished water supplies for compliance with drinking water standards. The assessment of Class 1B and 1C listed surface waters for potential impairment by nitrate nitrogen is discussed in this section.

### 1. Nitrate nitrogen

Nitrate nitrogen poses a risk to human health at concentrations exceeding 10 mg/L in drinking water. Humans, especially infants under six months of age, who are exposed to nitrate in drinking water at concentrations exceeding the 10 mg/L federal safe drinking water standard (which is incorporated by reference into Minn. R. ch. 7050.0221), can develop methemoglobinemia, a blood disorder that interferes with the ability of blood to carry oxygen.

The 10 mg/L standard is an acute toxicity standard. Long term, chronic exposure to nitrate in drinking water is less well understood but has been linked to the development of cancer, thyroid disease, and diabetes in humans.

In recognition of the trend of increasing nitrate concentrations in Minnesota streams and the public health and economic impact arising from elevated nitrate concentrations in drinking water (a particular concern in Southeast Minnesota's karst region), the MPCA assesses Class 1B and 1C designated surface waters for potential impairment by nitrate nitrogen.

### 2. Data requirements and determination of impaired condition

When assessing drinking water-protected surface waters Class 1B and 1C, MPCA compares 24-hour average nitrate concentrations to the 10 mg/L standard. Two 24-hour averages exceeding 10 mg/L within a three-year period indicates impairment.

Single measurements of nitrate concentrations under relatively stable conditions are generally considered to be sufficiently representative of 24-hour average concentrations for the purpose of assessments. When concentrations are more variable, multiple samples or time-weighted composite samples may be necessary in order to calculate a sufficiently accurate average concentration. The necessary number and type of samples can vary considerably from one situation to another and the determination of adequacy for the purpose of assessment will necessarily involve considerable professional judgment.

**Table 7. Summary of data requirements and exceedance thresholds for assessment of nitrate nitrogen, Class 1 drinking water standard.**

Period of record	Use-support or listing category	
Most recent 10 years	No more than 1 exceedance of the acute standard in 3 years:	2 or more exceedances of the acute standard in 3 years:
	Not listed	Listed

## VII. Pollutants with wildlife-based water quality standards

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Protection of the aquatic life use includes the protection of wildlife consumers of aquatic organisms. Minnesota has four wildlife-based WQS – all in Minn. R. ch. 7052, the Great Lakes Water Quality Initiative (GLI) rule. The GLI rule focuses on the reduction of bioaccumulative toxic chemicals in the Great Lakes ecosystem as a whole. The standards in Minn. R. ch. 7052 are applicable only to the surface waters of the Lake Superior basin in Minnesota. The GLI chronic wildlife-based standards are listed below:

- DDT – 11 pg/L
- Mercury – 1300 pg/L
- PCBs – 122 pg/L (GLI human health-based standards for PCBs are more stringent than the wildlife based standard)
- 2,3,7,8-TCDD – 0.0031 pg/L (GLI human health-based standards for dioxin are more stringent than the wildlife based standard for Lake Superior and Class 2A waters, but not for Class 2Bd and 2B, C & D waters)

The assessment of water bodies for compliance with the GLI wildlife-based standards follows the same protocols used to assess water bodies for human health-based standards, as described in the previous section ([Table 6](#)).

## VIII. Protection of aquatic recreation

This section addresses the assessment of water quality for pollutants that have aquatic recreation-based standards. Standards based on protecting the ability to recreate on and in Minnesota's waters are Class 2 standards. An overview of these standards and their application for assessment is provided below.

### A. Streams and rivers – *E. coli* bacteria

The numeric standards in Minn. R. ch. 7050 that directly protect for primary (swimming and other recreation where immersion and inadvertently ingesting water is likely) and secondary (boating and wading where the likelihood of ingesting water is much smaller) body contact are the *E. coli* (*Escherichia coli*) standards shown in [Table 8](#). *E. coli* standards are applicable only during the warm months since there is very little swimming in Minnesota in the non-summer months. Exceedances of the *E. coli* standard mean the recreational use is not being met.

The MPCA uses an *E. coli* standard based on a geometric mean EPA criterion of 126 *E. coli* colony forming units (cfu) per 100 mL. *E. coli* has been determined by EPA to be the preferred indicator of the potential presence of waterborne pathogens.

**Table 8. *E. coli* water quality standards for Class 2 and Class 7 waters.**

Use class	Standard		Applicable season	Use
	No. of organisms per 100 mL of Water			
	Monthly geometric mean*	10 % of samples maximum**		Body contact
2A, trout streams and lakes, 2Bd, 2B, 2C, non-trout (warm) waters	126	1260	April 1 – October 31	Primary
2D, wetlands	126	1260	April 1 – October 31	Primary, if the use is suitable
7, limited resource value waters	630	1260	May 1 – October 31	Secondary

\* Not to be exceeded as the geometric mean of not less than five samples in a calendar month.

\*\* Not to be exceeded by 10% of all samples taken in a calendar month, individually.

### 1. Data requirements and determination of impaired condition

There is a considerable amount of *E. coli* data available in Minnesota, and also older fecal coliform data. For assessment purposes, only results analyzed within 24 hours of sample collection will be used and only *E. coli* measurements will be used. Exceptions to the exclusive use of *E. coli* data will be made only in special cases, using a ratio of 200 to 126 to convert fecal coliform to *E. coli*.

Data over the full 10-year period are aggregated by individual month (e.g., all April values for all 10 years, all May values, etc.). At least five values for each month is ideal, while a minimum of five values per month for at least three months, preferably between June and September, is necessary to make a determination. Assessment with less than these minimums may be made on a case-by-case basis.

Where multiple bacteria/pathogen samples have been taken on the same day on an assessment unit, then the geometric mean of all the measurements on that day will be used for the assessment analysis.

If the geometric mean of the aggregated monthly values for one or more months exceeds 126 organisms per 100 mL, that reach is considered to be impaired. Also, a water body is considered impaired if more than 10% of individual values over the 10-year period (independent of month) exceed 1260 organisms per 100 mL. This assessment methodology more closely approximates the five-samples-per-month requirement of the standard while recognizing typical sampling frequencies, which rarely provide five samples in a single month and usually only one. [Table 9](#) summarizes the assessment process.

**Table 9. Assessment of water bodies for impairment of swimming use - data requirements and exceedance thresholds for *E. coli* bacteria.**

Period of record	Minimum no. of data points	Use-support or listing category based on exceedances of The <i>E. coli</i> standard	
Standard exceedance thresholds → Monthly geometric mean > 126 orgs/100 mL (Class 2) > 630 orgs/100 mL (Class 7)		No months	1 or more months
Most recent 10 years	see text	Not listed	Listed
Standard exceedance thresholds → Exceeds 1260 orgs/100 mL*		≤ 10 %	>10 %
Most recent 10 years	15	Not listed	Listed

\* In full data set over 10 years.

Expert review of the data provides a further evaluation. When fewer than five values are available for most or all months, the individual data are reviewed. Considerations in making the impairment determinations include the following:

- Dates of sample collection (years and months)
- Variability of data within a month
- Magnitude of exceedances
- Remark or data qualifier codes associated with individual values
- Previous assessments and 303(d) listings

In some circumstances where four values are available for some or all months, a mathematical analysis is done to determine the potential for a monthly geometric mean to exceed the 126 organisms/100mL standard. All assessments are reviewed by the Watershed Assessment Team (WAT) for each watershed.

## Large datasets

Aggregating data by month across years for very large datasets diminishes the value of the data and assessment, making it less likely that periodic *E. coli* exceedances will be identified that indicate impairment. Data aggregation should be held to a minimum, no more than necessary to have sufficient data to satisfy the requirements for determining exceedances.

Alternative methods of data analysis may be used based on a professional judgment review of the data. Where there are five values per individual month or 30-day time period, the data will not be aggregated and individual monthly or 30-day geometric means may be calculated. Alternatively, data may be aggregated by month across consecutive two-year or five-year time periods. If more than 10% of the geometric means calculated exceed the 126 org/100 mL standard, the AUID is assessed as not supporting.

## B. Great Lakes Shoreline (Lake Superior) beaches – *E. coli* bacteria

The Clean Water Act defines Coastal Recreation Waters as the Great Lakes and marine coastal waters (including coastal estuaries) that are designated under section 303(c) of the Clean Water Act for use for swimming, bathing, surfing, or similar water contact activities. The MPCA is applying the coastal waters definition and Beaches Environmental Assessment and Coastal Health (BEACH) Act water quality standards to all bacteria monitoring sites on the Lake Superior shoreline and in the mouths of tributaries that are representative of shoreline/Lake Superior conditions. The St. Louis River and Duluth-Superior Harbor sites monitored in the BEACH Act program that extends upstream in the St. Louis River to the Boy Scout Landing Beach are also considered within the coastal recreation designation. AUIDs were established for each individual beach, which generally includes only one beach monitoring station.

Lake Superior coastal waters are subject to *E. coli* WQS in the BEACH Act rule [November 2004 *Water Quality Standards for Coastal and Great Lakes Recreation Waters* rule (69 FR 67217, November 16, 2004), found at <http://www.gpo.gov/fdsys/pkg/FR-2004-11-16/html/04-25303.htm>]. These standards as applied in Minnesota are shown in [Table 10](#).

**Table 10. *E. coli* water quality standards for coastal recreation waters.**

Standard		Applicable Season	Use
No. of Organisms Per 100 mL of Water			
Monthly Geometric Mean*	10 % of Samples Maximum**		Body Contact
126	235	April 1 – October 31	Primary

\* Not to be exceeded as the geometric mean of not less than five samples in a calendar month.

\*\* Not to be exceeded by 10% of all samples taken in a calendar month, individually.

### 1. Data requirements and determination of impaired condition

There is a considerable amount of *E. coli* data collected as part of the BEACH monitoring program in Minnesota. Most beaches are monitored weekly from Memorial Day to Labor Day, while some are monitored twice weekly. To ensure use of the most recent data, data for the most recent five year period are used and assessments are made every other (odd numbered) year.



When there are five or more samples per individual month or 30 day time period, individual monthly geometric means are calculated and compared to the 126 orgs/100mL standard for the period April 1 through October 31. If more than 10% of the geometric means calculated exceed the 126 orgs/100mL standard, or if more than 10% of the individual sample results in the entire dataset exceed the maximum criterion of 235 orgs/100mL, the AUID is assessed as not supporting.

When sampling frequency results in smaller data sets, data is aggregated by month across years. If one or more of the monthly aggregated geometric means exceeds 126 orgs/100mL, or more than 10% of the individual sample results in the entire dataset exceed the maximum criterion of 235 orgs/100mL, the AUID is assessed as not supporting.

Data from adjacent sampling sites on the same beach are combined. For sites with both tributary mouth stations and BEACH stations, data from each station are assessed separately and the results considered using best professional judgment to make an assessment decision. For sites with only tributary mouth samples, the data are assessed against the coastal recreation water standards. Streams tributary to Lake Superior with bacteria data at stations upstream of the mouth are assessed as stream AUIDs using the statewide WQS and methodology in Part A. above.

The overall use-support assessment also requires best professional judgment to consider and integrate information regarding the timing, frequency, magnitude, and duration of exceedances along with other conditions present at the time of sampling. These longer-term use-support assessments based on several years of data are distinguished from the short-term beach advisory postings (water contact not recommended) that are based only on current 'real-time' data.

## **C. Lake eutrophication**

Excessive nutrient loads, in particular total phosphorus (TP), lead to increased algae blooms and reduced transparency – both of which may significantly impair or prohibit the use of lakes for aquatic recreation. The ecoregion-based eutrophication standards are the primary basis for aquatic recreational use assessments in lakes.

### **1. Water body classification and ecoregion determination**

As the eutrophication standards are specific to ecoregion and lake depth, a number of steps are required to be completed prior to the actual assessment of the water body. Statute defines lake, shallow lake, reservoir, and wetland (Minn. R. ch. 7050.0150). The determination between the four requires an analysis of basin depth and littoral area. Additionally, a series of questions was developed to help make the differentiation between shallow lake and wetland. These can be found in Appendix D. This step includes a desktop review using GIS and available morphometric data and may include a site visit, if the decisions cannot be made from this review. Decisions are recorded and stored in the assessment database for future reference.

Reservoirs with residence times less than 14 days will not be assessed as lakes, per EPA guidance (EPA 200a, Kennedy 2001). For this purpose, residence times are usually determined under conditions of low flow. A mean flow for the four-month summer season (June – September) with a once in 10-year recurrence interval is normally used. The MPCA may

establish a minimum residence time of less than 14 days on a site-specific basis if credible scientific evidence shows that a shorter residence time is appropriate for that reservoir.

The majority of the lakes in the state (98%) reside in four of the seven ecoregions (EPA Omernik Level III ecoregions). The remaining 2% of lakes reside in one of three ecoregions: Red River Valley, Northern Minnesota Wetlands, and the Driftless Area (Heiskary and Wilson 2005). Percent land use by categories (forest, pasture/open, cultivated, urban, water/wetland) are calculated for the lake watershed using the most recent national land cover dataset. These percentages are then compared to the breakdown of land use for the standards development dataset to see which ecoregion is more similar to the lake in question. The next step involves comparing morphometry of the lake basin (large, small, deep, shallow); different ecoregions have different lake characteristics. This data is used together to determine the proper ecoregion-based standard to address these lakes that do not fall in the ecoregions for which criteria have been developed and for lakes that are near an ecoregion boundary. See [Table 11](#) for Minnesota's ecoregion-based WQS.

## 2. Data requirements and determination of use assessment

### a) Minimum data requirements

Samples must be collected over a minimum of two years and data used for assessments must be collected from June to September. Typically, a minimum of eight individual data points for TP, corrected chlorophyll-*a* (chl-*a* corrected for pheophytin), and Secchi are required.

### b) Lake assessment determinations

Data used for phosphorus and chlorophyll-*a* calculations are limited to those collected from the upper most three meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-*a*, and Secchi depth. These values are then compared to the standards and the assessment is made ([Table 11](#)).

Lakes where TP and at least one of the response variables (corrected chl-*a* or Secchi) exceed the standards are considered impaired. For lakes with excellent data quality (2+ years of data) and where all parameters are better than the standards, an assessment of full support is made. Lakes with good quality data (1-year data plus Secchi trends) may be considered for full support assessment as well. In this case, the assessment thresholds have been adjusted by 20% (made more stringent) and lakes with good quality data that meet these thresholds will be considered fully supporting. This modification of the thresholds provides a margin of safety to assure that lakes with lesser amounts of data are supporting the beneficial use.

In some instances, a lake may have good or excellent quality data but only one of the thresholds is exceeded (e.g., only TP or only corrected chl-*a* or Secchi). In this instance, the lake will be considered to have insufficient data to assess because both the cause (TP) and at least one response (chl-*a* or Secchi) must either meet to indicate support or both exceed to indicate impairment. For lakes that do not meet minimum data requirements and use-support cannot be determined, a determination of insufficient data will be made.

### c) Reservoirs and other special situations

Sampling design and assessments for aquatic recreational use for reservoirs may be different from those used for lakes. Since reservoirs typically exhibit distinct zones, often referred to as inflow segment, transitional segment, and near-dam segment, calculation of “whole reservoir” mean TP may not be an appropriate basis for assessing aquatic recreational use. Rather, the MPCA may evaluate the status of the reservoir based on a specific segment – most likely the near-dam segment. In addition, water residence time may vary substantially as a function of river flow (e.g., Lake Pepin, Heiskary and Walker 1995) and may influence algal response to available nutrients. In addition, reservoirs often have very large watersheds that may drain portions of one or more ecoregion. Hence ecoregion-based standards based on where the reservoir is located may not always be the best basis for evaluating use-support.

Lakes with distinct bays, such as Lake Minnetonka, may present a similar situation. The bays (basins) may need to be assessed on an individual basis (data is stored by specific basin, not by whole lake). In some instances, a single bay may exceed the listing thresholds while other bays in the lake do not. In this case it should be determined whether the entire lake should be listed (e.g., there is distinct interaction between the bays) or simply the individual bay. This will likely require knowledge of flow-through patterns in the lake and assistance from local cooperators to make an appropriate determination.

**Table 11. Lake eutrophication WQS for aquatic recreation use assessments.**

Ecoregion	TP (µg/L)	chl- <i>a</i> (µg/L)	Secchi (m)
Northern Lakes and Forest – Lake trout (Class 2A)	< 12	< 3	> 4.8
Northern Lakes and Forest – Stream trout (Class 2A)	< 20	< 6	> 2.5
Northern Lakes and Forest – Aquatic Rec. Use (Class 2B)	< 30	< 9	> 2.0
North Central Hardwood Forest – Stream trout (Class 2A)	< 20	< 6	> 2.5
North Central Hardwood Forest – Aq. Rec. Use (Class 2B)	< 40	< 14	> 1.4
North Central Hardwood Forest – Aq. Rec. Use (Class 2B) Shallow lakes	< 60	< 20	> 1.0
Western Corn Belt Plains & Northern Glaciated Plains – Aq. Rec. Use (Class 2B)	< 65	< 22	> 0.9
Western Corn Belt Plains & Northern Glaciated Plains – Aq. Rec. Use (Class 2B) Shallow lakes	< 90	< 30	> 0.7

## IX. Protection of limited resource value waters (Class 7)

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Limited resource value waters include surface waters of the state that have been subject to a use attainability analysis and have been found to have limited value as a water resource. These waters are specifically listed in rule (Minn. R. ch. 7050.0470) and are protected so as to allow secondary body contact use, to preserve the groundwater for use as a potable water supply, and to protect aesthetic qualities of the water.

Standards for limited resource value waters include the following:

- *Escherichia (E.) coli*: Not to exceed 630 organisms per 100 mL as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than 10% of all samples taken during any calendar month individually exceed 1260 organisms per 100 mL. The standard applies between May 1 and October 31. Assessment methodology is described in detail in Section VIII.A.
- Dissolved oxygen: At concentrations which will avoid odors or putrid conditions or at concentrations not less than 1 mg/L as a daily average, provided that measurable concentrations are present at all times.
- pH: minimum value of 6.0, maximum value of 9.0.
- Toxic pollutants not allowed in such quantities or concentrations that will impair the specified uses.

Application of toxic standards to Class 7 waters for assessment purposes includes applying the Maximum Standard for most pollutants or 100 times the Chronic Standard (CS), whichever is lower (Minn. R. ch. 7050.0222, subp. 7, item E). However, for bioaccumulative pollutants the CS would apply. Because Class 7 waters may be used by game fish for spawning and/or maintaining minnow populations during brief periods in the spring, a special protection against bioaccumulative pollutants is needed.

## **X. Removal of water bodies from the 303(d) Impaired Waters List**

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There are four ways in which water bodies are removed from the 303(d) List:

- A. New and reliable data or information indicates that the water body is now meeting WQS.
- B. A TMDL plan for reducing the sources of pollution is completed and approved by the EPA.
- C. The sources of impairment are determined to be not caused by a pollutant or non-anthropogenic in origin.
- D. A correction to the list is required after it was determined that a water body was placed on the list in error, or reassessment with new standards or assessment methods does not indicate impairment.

It is important to note that in scenarios B and C above, the water body is still impaired and still appears on the Impaired Waters Inventory (until such time as the water body supports all its beneficial uses), but because a TMDL study is not required that water body is not included on the 303(d) List. The following paragraphs provide more details on the four scenarios above.

### **A. Water body no longer impaired**

In general, water body listing or delisting decisions will be made using the methods described in this Guidance. In practice, there will usually be more data available for the “delisting” assessment than was available for the “listing” assessment. New and old data will be considered together in the reassessments, unless tangible improvements of sufficient dimension to change impairment status have taken place in the reach, in which case only new data will be used in the delisting assessment. Improvements could include implementation of best management practices to reduce nonpoint sources, improvements in wastewater treatment, or some combination of nonpoint and point source reductions. If the new data show the water body to be un-impaired, the MPCA will recommend that the water body be delisted.

All delisting decisions are subject to review by the appropriate watershed assessment and professional judgment teams (see Section III) or the delisting committee for waters outside of the watersheds being assessed that year. Information about watershed improvements should be brought to the watershed assessment and professional judgment team or delisting committee for consideration. The MPCA will make a final determination on whether a water body can be considered no longer impaired, and should be submitted to the EPA for delisting.

It is essential that data used in the delisting assessment be collected under appropriate conditions. For DO and for pollutants with toxicity- and human health-based WQS, data should be from observations taken during critical conditions, i.e., those conditions most likely to result in exceedances of the standard. For example, if a water body was listed as impaired because of low DO, the measurements used to support delisting would likely need to be collected in the early morning (generally no later than two hours after sunrise, so as to reflect the daily minimum) during periods of very low flow. For other pollutants, data should be from observations that provide an accurate representation of the overall period of time under consideration and are not biased by, for example, being collected only during a certain season or under certain flow conditions.

The following is a summary of the specific data and assessment requirements needed to consider removing a water body from the 303(d) List, impaired because of exceedances of numeric standards:

**Total suspended solids must have:**

- At least 20 observations (new and old data) in the most recent 10 years, of which at least 10 observations (new and old data) are in the most recent 5 years.
- At least 20 observations (new data) in the most recent 5 years, and evidence of action in the watershed of sufficient dimension to change impairment status, and in either case, there must be fewer than 10% of samples exceeding the WQS.

**Dissolved oxygen must have:**

- At least 20 observations (new and old data) in the most recent 10 years, of which at least 10 observations (new and old data) are in the most recent 5 years, or at least 20 observations (new data) in the most recent 5 years, and evidence of action in the watershed of sufficient dimension to change impairment status.
- In either case, there must be fewer than 10% of samples exceeding the WQS.

**Un-ionized ammonia and chloride must have:**

- At least 5 observations (new and old data) for any 3-year interval in the most recent 10 years.
- At least 5 observations (new data) for any 3-year interval in the most recent 5 years, and evidence of action in the watershed of sufficient dimension to change impairment status.
- In either case, no more than one exceedance of the chronic WQS in any 3-year interval (chronic standard is a 4-day average).

**River eutrophication must have:**

- The causative variable (TP) and the response variable(s) that were used to list the AUID meet the standard.
- It will require a minimum of 12 paired samples over a minimum of 2 years for total phosphorus, chlorophyll-*a*, and/or biochemical oxygen demand.
- It will require a minimum of 20 pH samples over a minimum of 2 years.
- It will require a minimum of 2 DO sonde deployments; each with a length of a minimum of 4 days and occurring in separate years during a similar index period to the listing deployment within the assessment window.

**Trace metals data must have:**

- At least 5 observations for any 3-year interval in the most recent 10 years.
- No more than one exceedance of the chronic WQS in any 3-year interval (chronic standard is a 30-day average).

**Fish contaminants must have:**

- Five or more fish of the same species causing the impairment.
- A minimum of two years of data since the year the lake or river was added to the impaired waters list.
- Most recent data must show all fish species collected are not exceeding the threshold for impairment.
- Mercury concentration for a specific water body, species, and year has a 90th percentile less or equal to than 0.2 mg/kg (ppm).
- The data show a downward trend in the annual 90th percentiles.
- For PCBs and PFOS, FCA has been removed or reduced to less restrictive than a meal per month and arithmetic mean concentration is less than 200 µg/kg (ppb) for PFOS or less than 0.22 ppm for PCBs.

***E. coli* bacteria must have:**

- At least 15 observations over a two-year period in the most recent 10 years.
- A minimum of 5 values per month for at least 3 months when the standard is applicable April – October, but preferably between June and September; data are combined for each month over most recent 10 years, unless there are a sufficient number of observations to aggregate data by month over consecutive 2-year time periods, or to calculate individual monthly or 30-day geometric means.
- A minimum of 5 values per month for at least 3 months when the standard is applicable April – October, but preferably between June and September; data are combined for each month over most recent years since corrective actions were taken in the watershed of sufficient dimension to change impairment status, unless there are a sufficient number of observations to aggregate data by month over consecutive 2-year time periods, or to calculate individual monthly or 30-day geometric means.
- In either case, no exceedance of the monthly mean standard (126 organisms per liter) by the geometric mean in any of those months for 10-year aggregated data or less than 10% of months exceed the standard for 2-year aggregated or individual monthly or 30-day geometric means.
- In either case, fewer than 10% of sample observations exceed “maximum” standard (126 organisms per liter).

**Lake eutrophication must have:**

- At least 8 paired total phosphorus (TP), corrected chl-*a*, and Secchi measurements (June to September) over a minimum of 2 years for the most recent 10 years.
- If TP meets the standard, and either chl-*a* or Secchi meet the standard, the lake will be removed from the TMDL List.
- If TP exceeds the standard and corrected chl-*a* **and** Secchi meet the standard, and an improving trend in TP is observed or management activities are in place to maintain improved chl-*a* or Secchi observations, the lake may be delisted. This will require the local entity to provide information that details how the response conditions will be met over time.

**Biological indicators should have:**

- New data from the original listing station(s) indicating conditions are now supporting of aquatic life.
- An evaluation of any new biological data and other lines of evidence considered comprehensively, including upstream/downstream conditions, do not contradict a finding of full support.
- An evaluation that any stressors to the biology that may have been previously identified as part of the TMDL process indicate measured improvement.

Water bodies with impaired aquatic communities can be delisted utilizing the same criterion as listing (Section V. B) if additional bio-monitoring indicates that the community is no longer impaired when compared to the IBI threshold ( $\pm$ confidence interval). Overall assessment of whether an AUID adequately supports aquatic life involves the review of the parameter-level evaluations and data quality in conjunction with all available supporting information (flow, habitat, precipitation, etc.) to make an overall use-support determination. For a given AUID, there may be chemistry indicator data, biological indicator data, or both types of data available for assessment. The final assessment takes into consideration the strength of the various indicators and the quality of the data sets and, in addition, looks at upstream and downstream conditions to gain a better understanding of the interactions between the individual AUID and the larger water body and watershed.

Lakes and rivers listed as impaired because of fish tissue contaminants will be delisted when additional sampling and analysis show that the fish tissue concentrations, by species and size class, are below 0.2 mg/kg (mg/L) for either mercury or PCBs (in Section VI).

## **B. EPA-approved TMDL plan**

The most common way waters are removed from the 303(d) List is through the completion of the TMDL study. Under the current federal TMDL regulation, the TMDL process must progress through the step where an EPA-approved plan is in place that indicates in general how the river reach or lake is to be brought back into compliance with WQS. That is, under current EPA regulations, the water body does not need to be brought back to an un-impaired condition to be delisted. Irrespective of this EPA regulation, the MPCA is committed, with the help of local entities, to improving the water quality in all impaired waters so beneficial uses are restored, where restoration is possible. To that end, an AUID that has an approved TMDL plan for a pollutant no longer appears on the 303(d) List, but it remains on the Inventory of Impaired Waters with a 4A category until it is found to be no longer impaired.



## **C. Water body impaired because of a non-pollutant or natural background conditions**

A water body may be removed from the 303(d) list after it was determined that there are only non-pollutant sources contributing to the impairment. These sources might include changes to the water body such as dams, impoundments or other anthropogenic factors affecting stream connectivity or flow. These impairments remain on the Impaired Water List with a 4C Category.

If it is determined that an impairment is due to natural conditions with essentially no anthropogenic sources contributing to the impairment, that impairment can be removed from the 303(d) list but remain on the Impaired Waters List as with a Category of 4D.

## **D. List correction**

If a water body was placed on the list in error either by incorrect data, or due to an update in a standard or methodology that would not have caused an initial listing, the reach will be removed from the list as a correction.

# XI. Sources of information and MPCA contacts

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The readers of this document are encouraged to access the sources of information listed in this section. Included are email addresses and phone numbers of MPCA staff that work in areas relevant to the protocols and procedures in this Guidance. They are listed alphabetically by subject area. Also provided are some pertinent websites, listed by agency.

## A. MPCA staff

1. 303(d) List, Inventory of Impaired Waters, general questions and comments: Miranda Nichols at [miranda.nichols@state.mn.us](mailto:miranda.nichols@state.mn.us) or 651-757-2614
2. 305(b) integrated report: Miranda Nichols at [miranda.nichols@state.mn.us](mailto:miranda.nichols@state.mn.us) or 651-757-2614
3. Basin or watershed planning questions: Glenn Skuta at [glenn.skuta@state.mn.us](mailto:glenn.skuta@state.mn.us) or 651-757-2730
4. Biological impairment: Scott Niemela at [scott.niemela@state.mn.us](mailto:scott.niemela@state.mn.us) or 218-828-6076
5. Citizen lake monitoring program: Shannon Martin at [shannon.martin@state.mn.us](mailto:shannon.martin@state.mn.us) or 651-757-2874
6. Citizen stream monitoring program: Laurie Sovell at [laurie.sovell@state.mn.us](mailto:laurie.sovell@state.mn.us) or 651-757-2750
7. Effluent limits for toxic pollutants and temperature standard for cold water fisheries: Dann White [dann.white@state.mn.us](mailto:dann.white@state.mn.us) or 651-757-2820
8. Fish consumption advice: Minnesota Department of Health at 800-657-3908. Patricia McCann at [patricia.mccann@state.mn.us](mailto:patricia.mccann@state.mn.us)
9. Lake and river eutrophication methodology: Lee Engel at [lee.engel@state.mn.us](mailto:lee.engel@state.mn.us) or 651-757-2339
10. Limited Resource Value Waters (Class 7): Carol Sinden at [carol.sinden@state.mn.us](mailto:carol.sinden@state.mn.us) or 651-757-2727
11. TMDL process, general questions and comments: Celine Lyman at [celine.lyman@state.mn.us](mailto:celine.lyman@state.mn.us) or 651-757-2541
12. Data management and water quality data for specific water bodies: Jean Garvin at [jean.garvin@state.mn.us](mailto:jean.garvin@state.mn.us) or 651-757-2378
13. Water quality standards: Angela Preimesberger at [angela.preimesberger@state.mn.us](mailto:angela.preimesberger@state.mn.us) or 651-757-2656

**All MPCA staff can be reached toll free at 800-657-3864 or 651-296-6300 in the Twin Cities Metropolitan Area.**

## B. Websites

The MPCA and other agencies maintain a number of websites that provide information on aspects covered in this Guidance; some of the more pertinent sites are listed below:

## 1. MPCA websites

The MPCA home page is at <http://www.pca.state.mn.us>. From this site, the reader can link to all the MPCA websites listed below and many more.

1. Water quality standards, water quality rules, and general information:  
<https://www.pca.state.mn.us/water/water-quality-standards>
2. 305(b) Narrative Report: <https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list>
3. Lake protection, including Citizen Lake Monitoring Program and lake water quality:  
<https://www.pca.state.mn.us/water/lake-monitoring-0>
4. MPCA Quality Management Plan. Provides guidance on monitoring and data management, approved by the EPA: <https://www.pca.state.mn.us/sites/default/files/p-eao2-15.pdf>
5. Phosphorus strategy: <https://www.pca.state.mn.us/water/phosphorus>
6. Quality assurance and quality control requirements for water quality sampling and data assessment for lakes and streams: <https://www.pca.state.mn.us/about-mpca/mpca-quality-system>
7. Minnesota's Impaired Waters List: <https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list>
8. TMDL projects: <https://www.pca.state.mn.us/water/total-maximum-daily-load-tmdl-projects>
9. Surface Water Data website with environmental data on surface waters statewide:  
[http://cf.pca.state.mn.us/water/watershedweb/wdip/search\\_more.cfm](http://cf.pca.state.mn.us/water/watershedweb/wdip/search_more.cfm)

## 2. Minnesota Department of Health websites, fish consumption advice

1. Fish consumption advice, general:  
<https://www.health.state.mn.us/communities/environment/fish/index.html>
2. Site-specific advice:  
<https://www.health.state.mn.us/communities/environment/fish/eating/sitespecific.html>

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## XIII. Appendices

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### Appendix A. State overall and beneficial use reporting categories

Category	Description
2	Waterbody's assessed designated uses are fully supported, the designated use is fully supported, or parameter meets standards.
3	Data insufficient or inconclusive to assess.
4A	Impaired and a TMDL study has been approved by EPA.
4B	Impaired but a TMDL study is not required because water quality standards are expected to be met in the near future.
4C	Impaired but a TMDL study is not required because the impairment is not caused by a pollutant.
4D	Impaired but a TMDL study is not required because the impairment is due to natural conditions with insignificant anthropogenic influence. To be considered insignificant, the elimination of the anthropogenic influence would not lead to the attainment of water quality standards and it would not be included in formal pollution reduction goal-setting activities. Category 4D indicates a site-specific water quality standard based on local natural conditions has yet to be determined.
4E	Impaired but existing data strongly suggests a TMDL study is not required because impairment is not caused by a pollutant or is due to natural conditions with only insignificant anthropogenic influence; a final determination of Category 4C or 4D will be made in the next assessment cycle pending confirmation from additional information.
5	Impaired and a TMDL study has not been approved by EPA.

## Appendix B. Minnesota's TMDL priorities

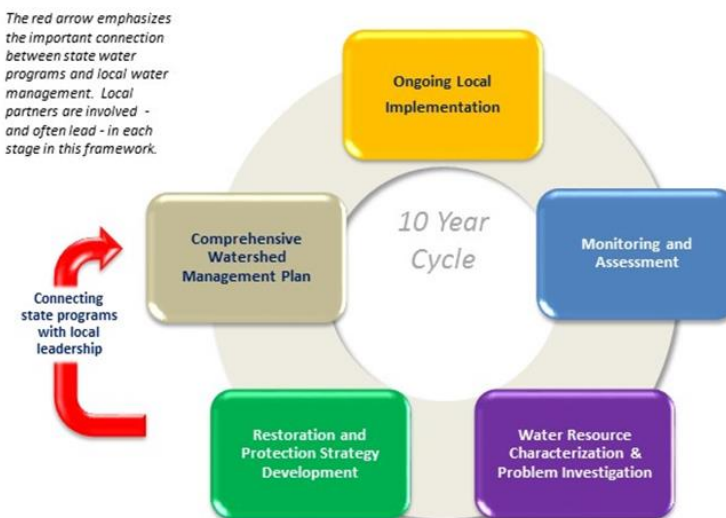
The MPCA has prioritized Total Maximum Daily Loads (TMDLs) for the years 2016-2022 as part of EPA's Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program. These TMDL priorities are a subset of our section 303(d) Impaired Waters List and reflect our priorities identified by the TMDL Start and Completion dates on the list. Minnesota's TMDL priorities identified for the prioritization goal of EPA's Long-Term Vision are those water bodies listed for conventional pollutants with an estimated TMDL Completion date of 2021 or earlier. Water bodies listed for nonconventional pollutants (chloride and mercury for example) will continue to be done according to the 303(d) list dates, but they will be done through a separate process rather than through the watershed approach. A small number of water bodies listed for conventional pollutants have been deferred to later dates when Cycle 2 of the watershed approach is in progress. For the entire TMDL Priority Framework Report, go to the MPCA's TMDL policy and guidance webpage at <https://www.pca.state.mn.us/water/tmdl-policy-and-guidance>.

**Conventional pollutants:** WRAPS reports will be done on a 10-year watershed cycle and the TMDLs for conventional pollutants in those watersheds will be done as part of the WRAPS process, with some exceptions (see deferred TMDLs below). The conventional pollutants are DO, pH, temperature, turbidity, TSS, bacteria, ammonia, nitrates, nutrients, and biological impairments.

**What is the WRAPS Report?** The State of Minnesota has adopted a watershed approach to address the state's 80 major watersheds (denoted by 8-digit hydrologic unit code or HUC). This watershed approach incorporates water quality assessment, watershed analysis, civic engagement, planning, implementation, and measurement of results into a 10-year cycle that addresses both restoration and protection. The Watershed Restoration and Protection Strategy (WRAPS) report is done as a result of that work. In addition to the WRAPS report, a watershed TMDL study is done.

As part of the watershed approach, waters not meeting state standards are still listed as impaired and studies are performed, as they have been in the past, but in addition the watershed approach process facilitates a more cost-effective and comprehensive characterization of multiple water bodies and overall watershed health. A key aspect of this effort is to develop and utilize watershed-scale models and other tools to identify

strategies and actions for point and nonpoint source pollution that will cumulatively achieve water quality targets. For nonpoint source pollution, this report informs local planning efforts, but ultimately the local partners decide what work will be included in their local plans. The WRAPS report provides a HUC8-level strategy to address the impairments and protection needs in the watershed and allows for local partners to develop more specific plans at the local level. The Section 319 Small Watersheds program is working with local governments to develop very detailed nine element plans on a smaller scale to qualify for Section 319 grant funding.





## Appendix C. Sources of data used for assessment

Involvement of local units of government and other governmental agencies in the monitoring of water quality is always encouraged, and the MPCA actively seeks data from all sources utilizing appropriate QA/QC with annual calls for data.

Analytical labs providing data must be certified under the lab certification program operated by MDH, and the data to be used in assessments should be entered into the MPCA's ambient water quality database, EQuIS (Environmental Quality Information System). A major aspect of monitoring that the MPCA must consider when reviewing data for use in assessments is the purpose for which the data were collected. For example, samples collected to characterize "events" such as the effects of storm runoff on a river may not be suitable, if used alone, to characterize the overall water quality of the river.

Data from any source that has been entered in EQuIS (or another MPCA database), reviewed, and found to satisfy QA/QC requirements will be considered for use in assessments. Major examples include:

- Data collected through the MPCA monitoring programs
- Data collections funded by state or federal money (e.g., Clean Water Partnership or Lake Assessment Program data)
- Data from any source readily accessible through EQuIS
- Data in an electronic format from which assessments can be made directly, or in a form easily entered into EQuIS (e.g., data collected by governmental or other major entities that provide monitoring data in places where MPCA has little or no monitoring)
- Data in a form amenable to EQuIS entry that fills an important gap in MPCA data
- Minnesota Department of Agriculture water quality data
- Continuous water quality data (e.g., flow, DO, temperature collected internally or by parties outside the MPCA) accessible through the MPCA/DNR's shared database for continuous data.

Data obtained through projects the MPCA funds must be the result of a clearly defined and documented purpose and it must satisfy specific data needs. This documentation is called an "information protocol," and it has proven to be very useful to MPCA staff considering the broad range of types and purposes of monitoring programs carried out by agencies and other organizations.

The MPCA may also search out data from sources not amenable to EQuIS entry. Sources of water quality data outside the MPCA that are considered each year for use in water quality assessments include:

- Neighboring states and tribes in Minnesota (found in EPA's Water Quality Data Portal)
- Metropolitan Council Environmental Services
- United States Geological Survey (found through USGS's National Water Information System or Long Term Resource Monitoring Program [LTRMP])
- Any other source that may be pertinent to that year's assessments

When receiving monitoring data collected by neighboring states and tribes, the MPCA, on a case-by-case basis, may consider the use of this data in the state's assessment process. Professional judgment groups will consider the proximity of the collection point to Minnesota, including any intervening tributaries between the monitoring location and the Minnesota border that may affect the ability of the monitoring site to represent the Minnesota water body. In addition, MPCA staff will use such data where it is made available through our calls for data, but will not actively seek out non-Minnesota-collected data. Data from non-Minnesota sources will have to meet all the existing data standards for consideration in assessments, including entry into EQuIS.

## Appendix D. Lake, shallow lake, and wetland differentiation

Some of the factors used to separate lakes, shallow lakes, and wetlands are as follows:

Factor	Lakes	Shallow lakes	Wetlands
Protected Waters Inventory (PWI) Code	Typically coded as “L or LP” in PWI	May be coded as either “L, LP or LW” in PWI	Typically coded as a “LW” in PWI
Depth, maximum	Typically >15 feet	Typically < 15 feet	Typically < 7 feet
Littoral area	Typically <80%	Typically >80%	Typically 100%
Area (minimum)	Typically > 10 acres (NDH)	Typically > 10 acres (NDH)	No minimum
Thermal stratification (summer)	Stratification common but dependent upon depth, size and fetch	Typically do not thermally stratify	Typically do not stratify.
Fetch*	Significant fetch depending on size & shape	Fetch is variable depending on size & shape	Rarely has a significant fetch
Substrate	Consolidated sand/silt/gravel	Consolidated to mucky	Mucky to unconsolidated
Shoreline features	Generally wave formed, often sand, gravel or rock	Generally wave formed, often sand, gravel or rock	Generally dominated by emergents
Emergent vegetation & relative amount of open water*	Shoreline may have ring of emergents; vast majority of basin open water.	Emergents common, may cover much of fringe of lake; basin often has high percentage of open water.	Emergents often dominate much of basin; often minimal open water.
Submergent vegetation	Common in littoral fringe, extent dependent on transparency	Abundant in clear lakes; however may be lacking in algal-dominated turbid lakes.	Common unless dominated by an emergent like cattail.
Dissolved Oxygen	Aerobic epilimnion; hypolimnion often anoxic by midsummer	Aerobic epilimnion but wide diurnal flux possible	Diurnal flux & anaerobic conditions common
Fishery	Typically managed for a sport/game fishery. May be stocked. DNR fishery assessments typically available.	May or may not be managed for a sport fishery. If so, fishery assessment should be available. Winter aeration often used to minimize winterkill potential.	Typically not managed for a sport fishery. Little or no DNR fishery information. Seldom aerated May be managed to remove fish & promote waterfowl.
Uses	Wide range of uses including boating, swimming, skiing, fishing; boat ramps & beaches common	Boating, fishing, waterfowl production, hunting, aesthetics; limited swimming; may have boat ramp, beaches uncommon	Waterfowl & wildlife production, hunting, aesthetics. Unimproved boat ramp if any. No beaches.

\* Fetch and open water play a large role in these determinations.

## Appendix E. Assessing and communicating the quality of waters that occur wholly or partially within federally recognized Indian reservations

**Goal:** Work with tribes to monitor, assess, and communicate the quality of waters that are within, or partially, within the boundaries of Indian reservations.

**Background:** Measuring and communicating water quality is core to the mission of the MPCA. The Clean Water Act requires delegated programs to determine if waters are meeting standards designed to protect uses like fishing and swimming.

Waters that do not meet water quality standards (WQS) are designated as “impaired.” Delegated programs are required to submit a draft list of impaired waters to the U.S. Environmental Protection Agency (EPA) for approval every two years and establish a TMDL of pollutants that, if met, will result in attaining the standards. In addition to federal law requirements, Minnesota state law<sup>3</sup> requires the MPCA to determine if any waters of the state<sup>4</sup> are impaired. Because of the broad definition of waters of the state, the state’s impaired waters requirement applies to more waterbodies than the federal requirements. Therefore, the MPCA includes a state-only impaired waters list with the required federal list in order to have a comprehensive listing of impaired waters within Minnesota.

The Grand Portage Band and Fond du Lac Band have received EPA delegation, known as “treatment as a state” (TAS), to establish WQS and have adopted water quality standards that have been approved by EPA. Several other Bands are in the process of applying for TAS for water quality standards. The Leech Lake Band has submitted their TAS application to EPA. EPA public noticed the application on May 31, 2019 and took comments through July 15, 2019. A final decision is pending, but MPCA anticipates that Leech Lake will also receive TAS status. On October 26, 2016, EPA adopted regulations to establish a process for eligible tribes to obtain TAS to list waters within their reservations as impaired under section 303(d) and establish TMDLs.

The MPCA uses a watershed approach to monitor the chemical and biological condition of waters around the state. This approach includes working with tribes to develop a monitoring plan for waters that occur wholly or partially within the boundaries of Indian reservations that is mutually agreeable and beneficial. Following two years of watershed monitoring, MPCA scientists strive to work with local resource managers, including tribal staff familiar with the monitoring efforts, to evaluate the data and determine if waters are meeting state WQS. The MPCA makes a draft impaired waters list available for public comment prior to submittal to EPA.

The MPCA recognizes that both states and tribes (whether or not they have obtained TAS for the WQS program) are invested in protecting and restoring all waters. The MPCA also recognizes that EPA has stated that its approval of the State’s 303(d) impaired waters list does not extend to waters within

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<sup>3</sup> Minn. Stat. §§ 115.03, subd. 1 and 115.44; Minn. Laws 2005, 1st Sp.1, ch. 1, art. 2, § 151; and Minn. R. 7050.0150 (impaired waters authority). See also Minn. Stat. ch. 1140 and Minn. R. 7052.0200 (TMDL authority).

<sup>4</sup> Minn. Stat. § 115.01, subd. 22. “Waters of the state” means all streams, lakes, ponds, marshes, watercourses, waterways, wells, springs, reservoirs, aquifers, irrigation systems, drainage systems and all other bodies or accumulations of water, surface or underground, natural or artificial, public or private, which are contained within, flow through, or border upon the state or any portion thereof.

Indian reservations<sup>5</sup>, including fee and parcels held in trust (tribal trust lands), and that EPA will take no action to approve or disapprove the list with respect to waters within Indian reservations for purposes of section 303(d).

**Proposed approach for assessing and communicating water quality:** Given that people across the state use waters, we would like to establish a common understanding about how data for waters wholly or partially within reservation boundaries will be evaluated and communicated. The MPCA offers the following approach:

1. MPCA will continue to work with tribes in advance of monitoring to agree on plans that include locations, parameters, roles, responsibilities and processes.
2. MPCA will share data with tribes and will engage tribes in the evaluation of monitoring data in light of applicable state WQS. The MPCA likewise appreciates tribes sharing their monitoring data.
3. For waters deemed to be impaired that:
  - a. Are partially within the boundaries of a federally recognized Indian reservation (but are not located wholly within a federally recognized Indian reservation, or serve as a border between a federally recognized Indian reservation and Minnesota land), the MPCA will include such waters on Minnesota's Impaired Waters List and include a footnote with each that states: *"This body of water is partially within a federally recognized Indian reservation and does not serve as a border between a federally recognized Indian reservation and Minnesota land. The state and tribe have worked cooperatively on this water quality assessment and agree that the water should be included on the State's impaired waters list. For the purposes of the 303(d) list, the assessment of the portion of the waterbody within the reservation is provided as information only to EPA because EPA does not approve the State's impaired waters listings for purposes of section 303(d) for waters within the boundaries of an Indian reservation. Note that the MPCA includes fee lands and parcels held in trust (tribal trust lands) in the definition of Indian reservation."*
  - b. Are located wholly within a federally recognized Indian reservation, the MPCA will send a list of these waters to EPA, separate from the impaired water list but accompanying the list and include the following statement in the title of this list: *"This assessment list was prepared under authority in state law to determine whether waters within the state are impaired. The MPCA includes this state-only list in order to have a comprehensive list of impaired waters. For purposes of the 303(d) list, these assessments are provided as information only to EPA because these water bodies are located wholly within a federally recognized Indian reservation and EPA does not approve the State's impaired waters listings for purposes of section 303(d) for waters that are within the boundaries of an Indian reservation. Note that the MPCA includes fee lands and parcels held in trust (tribal trust lands) in the definition of Indian reservation."*
4. Prior to putting the draft Impaired Waters List on public notice, the MPCA will communicate with tribes and will use electronic map tools to highlight waters that are partially or wholly within reservation boundaries and determined to be impaired using state WQS. Such waters will be indicated with a footnote or included on the separate 'wholly' list as specified in #3 above.

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<sup>5</sup> Language from EPA's Approval Letter of MPCA's 2018 Impaired Waters List "EPA's approval of Minnesota's Section 303(d) list extends to all water bodies on the list with the exception of those waters that are within Indian Country, as defined in 18 U.S.C. § 1151. EPA is taking no action to approve or disapprove the State's list with respect to those waters at this time. EPA, or eligible Indian Tribes, as appropriate, will retain responsibilities under CWA Section 303(d) for those waters".

5. MPCA and tribal representatives will discuss and determine whether there is a mutual desire to cooperatively develop restoration and protection strategies, including TMDLs, for impaired waters that are partially or wholly within reservation boundaries.

## Appendix F. Supplemental information on biological assessment in Minnesota

### Basis for assessment of biological community

Assessment of the biological community for impairment is based on the narrative water quality standards (WQS) and assessment factors in Minn. R. ch. 7050.0150. The most relevant part, Minn. R. ch. 7050.0150, subp. 6 is quoted below:

*Subp. 6. Impairment of biological community and aquatic habitat. In evaluating whether the narrative standards in subpart 3, which prohibit serious impairment of the normal aquatic biota and the use thereof, material alteration of the species composition, material degradation of stream beds, and the prevention or hindrance of the propagation and migration of aquatic biota normally present, are being met, the commissioner will consider all readily available and reliable data and information for the following factors of use impairment:*

- A. An index of biological integrity calculated from measurements of attributes of the resident fish community, including measurements of:*
  - 1) species diversity and composition;*
  - 2) feeding and reproduction characteristics; and*
  - 3) fish abundance and condition.*
- B. An index of biological integrity calculated from measurements of attributes of the resident aquatic invertebrate community, including measurements of:*
  - 1) species diversity and composition;*
  - 2) feeding characteristics; and*
  - 3) species abundance and condition.*
- C. An index of biological integrity calculated from measurements of attributes of the resident aquatic plant community, including measurements of:*
  - 1) species diversity and composition, including algae; and*
  - 2) species abundance and condition.*
- D. A quantitative or qualitative assessment of habitat quality, determined by an assessment of:*
  - 1) stream morphological features that provide spawning, nursery, and refuge areas for fish and invertebrates;*
  - 2) bottom substrate size and variety;*
  - 3) variations in water depth;*
  - 4) sinuosity of the stream course;*
  - 5) physical or hydrological alterations of the stream bed including excessive sedimentation;*
  - 6) types of land use in the watershed; and*
  - 7) other scientifically accepted and valid factors of habitat quality.*
- E. Any other scientifically objective, credible, and supportable factors.*

A finding of an impaired condition must be supported by data for the factors listed in at least one of items A to C. The biological quality of any given surface water body will be assessed by comparison to the biological conditions determined by the commissioner using a biological condition gradient model or a set of reference water bodies which best represents the most natural condition for that surface water body type within a geographic region.

Additional language supporting the use of narrative WQS in wetlands is found in Minn. R. ch. 7050.0222, subp. 6, which defines the protection of Class 2D waters (wetlands) as follow:

*“The quality of Class 2D wetlands such as to permit the propagation and maintenance of a healthy community of aquatic and terrestrial species indigenous to wetlands, and their habitats. Wetlands also add to the biological diversity of the landscape. These waters shall be suitable for boating and other forms of aquatic recreation for which the wetland may be usable. This class of surface water is not protected as a source of drinking water. ...”*

In addition to the narrative language in rule, which supports assessment of biological communities and habitat, Minnesota rules also include numeric biological criteria for assessment of fish and macroinvertebrates in streams and rivers. These biocriteria are found in Minn. R. ch. 7050.0222, subps. 2d, 3d, and 4d (Table 12). This rule language includes biocriteria values for both fish and macroinvertebrates, for different stream types and TALUs. Supporting documentation incorporated by reference into rule for these biocriteria are found in Minn. R. ch. 7050.0222, subps. 2c, 3c, and 4c. These documents include fish and macroinvertebrate data collection protocols, IBI calculation, BCG model development, and biocriteria development for streams.

**Table 12. Tiered aquatic life use (TALU) numeric biological criteria for the assessment of fish and macroinvertebrate communities in rivers and streams using the index of biological integrity or IBI.**

	Class	Class Name	Use Class	General (g) Use IBI Threshold	Exceptional (e) Use IBI Threshold	Modified (m) Use IBI Threshold	90% Confidence Limit (±)
Fish IBI Classes	1	Southern Rivers	2B	49	71		11
	2	Southern Streams	2B	50	66	35	9
	3	Southern Headwaters	2B	55	74	33	7
	4	Northern Rivers	2B	38	67		9
	5	Northern Streams	2B	47	61	35	9
	6	Northern Headwaters	2B	42	68	23	16
	7	Low Gradient	2B	42	70	15	10
	10	Southern Coldwater	2A	50	82		13
	11	Northern Coldwater	2A	35	60		10
Macroinvertebrate IBI Classes	1	Northern Forest Rivers	2B	49	77		10.8
	2	Prairie Forest Rivers	2B	31	63		10.8
	3	Northern Forest Streams RR	2B	53	82		12.6
	4	Northern Forest Streams GP	2B	51	76	37	13.6
	5	Southern Streams RR	2B	37	62	24	12.6
	6	Southern Forest Streams GP	2B	43	66	30	13.6
	7	Prairie Streams GP	2B	41	69	22	13.6
	8	Northern Coldwater	2A	32	52		12.4
	9	Southern Coldwater	2A	43	72		13.8

The aquatic life use-support assessment methodology described in this Guidance fully supports the narrative and numeric standards in Minnesota rule and protects the biological integrity of rivers, streams, and wetlands by:

- Measuring attainment directly through sampling of the aquatic biota
- Controlling biological and sampling variability through regionalization, classification and strict adherence to sampling protocol
- Establishing impairment thresholds based on data collected from reference (least-disturbed) waters of the same class

- Incorporating a confidence limit (based on the repeatability of the IBI) to account for variability within the aquatic community because of natural spatial and temporal differences and sampling or method errors

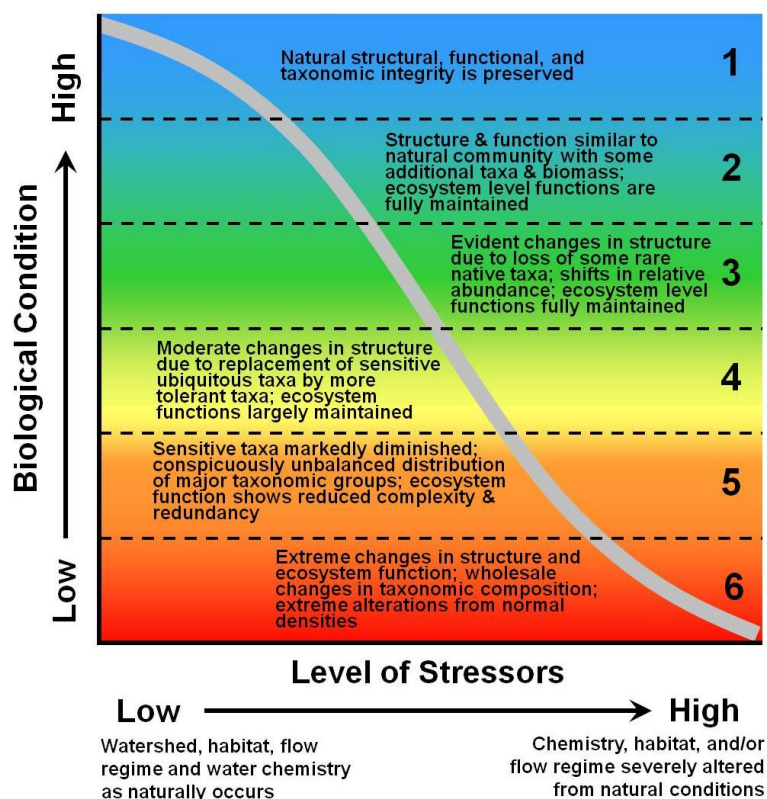
### **Biological condition gradient**

The Biological Condition Gradient (BCG) is a conceptual model of aggregated biological knowledge used to describe changes in biological communities along a gradient of increasing stress. This model is based on a combination of ecological theory and empirical knowledge. A number of indices have been developed to measure the biological condition in aquatic systems (e.g., IBI, RIVPACS; Karr et al. 1986, Hawkins et al. 2000, Whittier et al. 2007), but these measures are based on the available conditions that are used to develop the models. The BCG differs from these in that it provides a common “yardstick” of biological condition that is rooted in the natural condition. As a result, the BCG can be used to develop biocriteria that are consistent across regions and stream types in Minnesota. This is particularly important for a state such as Minnesota where the range of conditions are regionally distinct and extreme (i.e., relatively pristine to degraded). The BCG divides biological condition into six levels that are intended to be manageable and useful for water quality managers (see BCG model below). More detailed descriptions of the BCG can be found in EPA (2005) and Davies and Jackson (2006).

The development of the BCG models for warm water rivers and streams and lakes involved input from biological experts from the MPCA and DNR familiar with aquatic communities in Minnesota. BCG models were developed for fish and macroinvertebrates for each of the seven warm water stream classes and for four groups of lakes. A cold water BCG for streams was also developed and involved experts from Minnesota, Wisconsin, Michigan, and several tribes. In Minnesota, this included two classes each for fish and macroinvertebrates. Model development for each stream class involved reviewing biological community data from monitoring sites and then assigning that community to a BCG level (1-6). Similar model development was completed for lakes, utilizing the four lake groups. A sufficient number of samples were assessed to develop a model which can duplicate the panel’s BCG level assignments. This model ([Figure 3](#)) was then used to assign BCG levels to all monitoring sites in MPCA’s biological monitoring database for streams and MDNR’s Lake Database for lakes.



Figure 3. Model used to assign BCG levels to Minnesota’s biological monitoring sites.



### Selection of reference sites for rivers and streams

Minnesota has developed an index to measure *a priori* the degree of human disturbance at a stream class called the Human Disturbance Score (HDS) (Table 13). The HDS includes both watershed and reach level measures of human disturbance which when combined have a maximum score of 81 (see Table 4. Metrics and scoring for Minnesota’s Human Disturbance Score see Table 13 below). Reference sites were identified as those with an HDS score of 61 or greater (i.e., a 25% decline from the maximum score). Once sites were selected based on their HDS score, an additional filter was applied to remove sites disparately influenced by nearby stressors. All sites in close proximity to urban areas (site within or adjacent to urban area), feedlots (feedlot at or immediately upstream of site [only streams >50 mi<sup>2</sup>]), or point sources (continuous point source <5 mi upstream of site) were removed. The remaining sites (i.e., those meeting the HDS threshold and meeting the proximity criteria) were considered to be minimally or least disturbed and therefore representative of attainment of Minnesota’s aquatic life use goals. Reference sites were selected from each of the fish and macroinvertebrate classes and the 25<sup>th</sup> percentile of IBI scores was determined.

**Table 13. Metrics and scoring for Minnesota's Human Disturbance Score.**

Human Disturbance Score Metric	Scale	Primary Metric or Adjustment	Maximum Score
Number of animal units per sq km	watershed	primary	10
Percent agricultural land use	watershed	primary	10
Number of point sources per square km	watershed	primary	10
Percent impervious surface	watershed	primary	10
Percent channelized stream per stream km	watershed	primary	10
Degree channelized at site	reach	primary	10
Percent disturbed riparian habitat	watershed	primary	10
Condition of riparian zone	reach	primary	10
Number of feedlots per sq km	watershed	adjustment	-1
Percent agricultural land use on >3% slope	watershed	adjustment	-1
Number of road crossings per sq km	watershed	adjustment	-1 or +1
Percent agricultural land use in 100m buffer	watershed	adjustment	-1
Feedlot adjacent to site	reach (proximity)	adjustment	-1
Point source adjacent to site	reach (proximity)	adjustment	-1
Urban land use adjacent to site	reach (proximity)	adjustment	-1
		Maximum	81

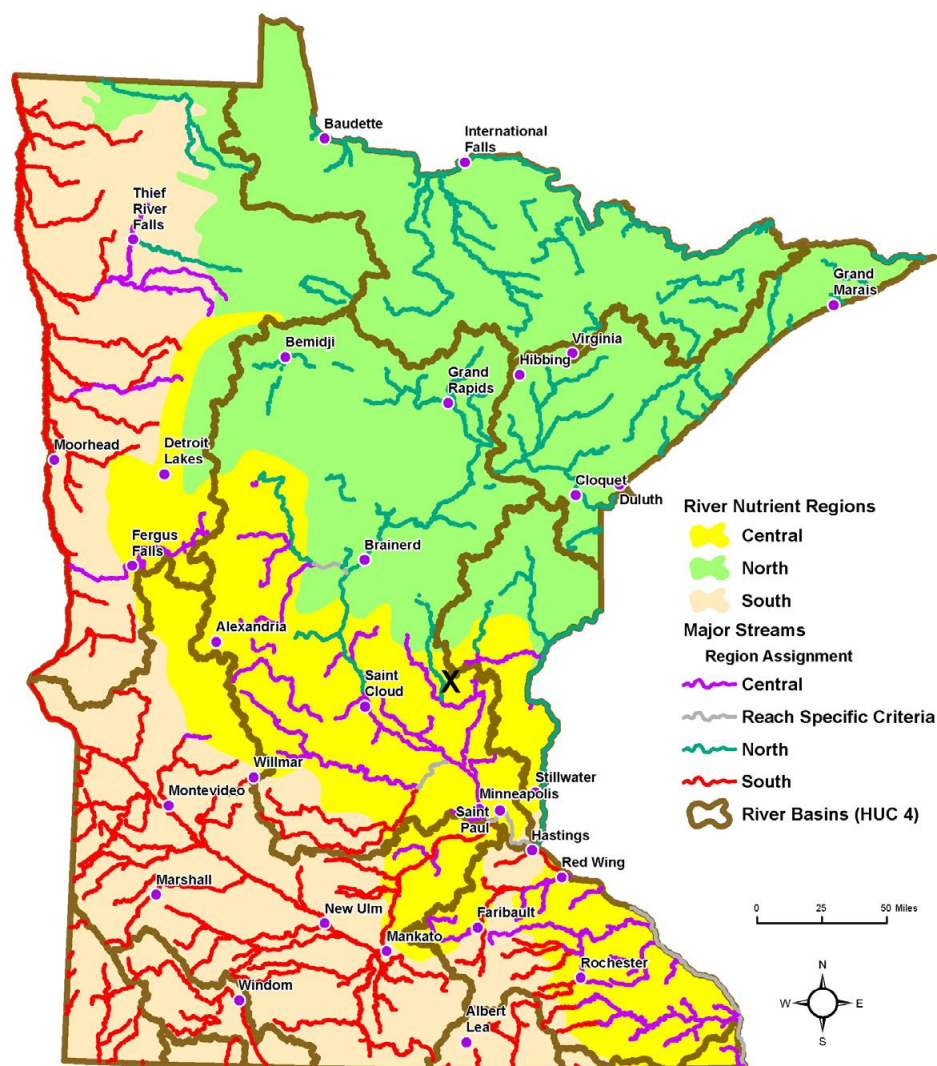
## Appendix G. Supplemental information on river eutrophication assessment in Minnesota

The following information is intended to guide the completion of the RES assessments. This includes determination of the correct regional standard to apply, data requirements and summarization, and guidance for specific situations encountered during the assessments.

### Assignment of regional standards

When an HUC-8 watershed is located wholly within a RNR ([Figure 4](#)), or where a vast majority of the watershed is within a single RNR, the RNR assignment is made to the dominant RNR. When a HUC-8 is characterized by multiple RNRs, a closer inspection was required and 11-digit HUCs (Watershed 99 HUC 11 layer) were incorporated into the mapping coverage to allow for refinement of boundaries to determine the appropriate RNR assignment. In a few instances, where two 8-digit HUCs meet prior to entering the major mainstem river (e.g. North Fork and South Fork Crow Rivers) a site-specific standard was required and these reaches are noted on the RNR map. Heiskary and Parson (2013) provide further details on the mapping approach.

**Figure 4. Statewide River Nutrient Region map.**



During the assessment, the assigned RNR should be reviewed if there are questions regarding the AUID classifications when a river flows from one RNR to the next or where adjacent or upstream/downstream AUIDs have different RNR designations.

### **Minimum data requirements for TP, chl-*a* corrected for pheophytin or BOD<sub>5</sub> and pH**

The rule and the legal documents supporting and explaining the rule (SONAR Book 2, Minn. R. ch. 7050, and Heiskary et. al. 2013) describe the following minimum data parameters:

- **Number of years.** Samples must be collected over a minimum of two years within the most recent 10-year time period (SONAR Book 2).
- **Time of year.** Data used for assessments must be collected from June to September (Minn. R. ch. 7050).
- **Number of TP data points.** Based on a minimum of two years of monitoring, a minimum of six individual data points per summer for the causative variable TP must be collected (as noted in SONAR Book 2, pp. 81).
- **Response variables.** In addition, the response variables (chl-*a* corrected for pheophytin or BOD<sub>5</sub> or pH) are collected concurrent with TP. A minimum of 12 measurements considering the above minimum data requirements for the 10-year assessment period are required for an assessment to be conducted (SONAR Book 2). While this minimum will typically be achieved over two years of sampling, it may also be achieved by multiple years (e.g. three years with four samples per year).

The term “representative” is used repeatedly in these definitions and implies that samples are to be collected across the summer season so they “represent” the entire season. Since river flow varies during individual summers and among summers, it is assumed samples will be collected over a range of flows; hence, the need to collect multiple samples over each summer and the need for two or more years of sample collection. While no specific flows are established for (or prohibited from) sample collection, the river must exhibit some amount of unidirectional flow for samples to be collected. If flows are so low that water is pooled or stagnant at the sample site and there is no evident downstream flow, these conditions must be documented and samples should not be utilized for river eutrophication assessment.

### **Data requirements specific to diel dissolved oxygen flux assessment**

Diel DO flux is measured by means of probes (also referred to as a sonde) that are deployed for a minimum of four consecutive days in the river reach (AUID) being assessed. While these measures could be conducted at any time within the June through September timeframe, it is preferred that the measures be taken late summer from mid-July through August. Ideally, flows are relatively stable during the time the sonde is deployed. Due to interannual variability and the varied duration of single-year diel DO deployments, sonde deployments must meet the minimum deployment length and deployments must occur in a minimum of two summers in the assessment period to be considered representative of river conditions. Details on methods for collecting instrumented DO data for the calculation of diel DO flux are provided in technical support documents (Heiskary et al. 2013 and Heiskary and Markus 2003).

### **Determination of use assessment**

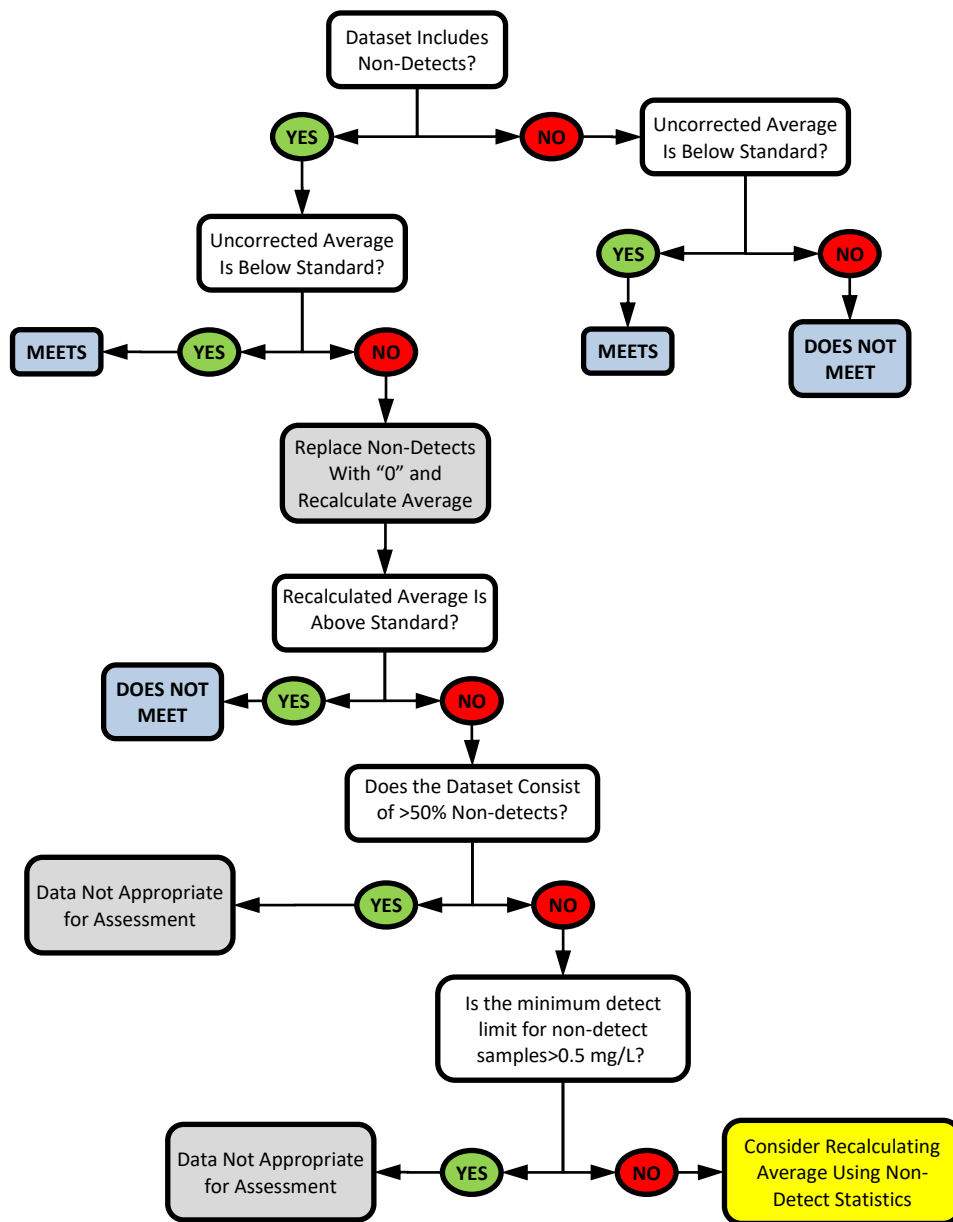
The final step in assessment is determining if the RES has been met or exceeded for the water body based on the data collected. Minnesota’s RES is a two-part standard involving a causative variable (TP) and response variables that indicate the presence of eutrophication (i.e. undesirable levels of sestonic or suspended algae, benthic or attached algae, or excessive rooted vegetation). For assessment purposes this means the cause indicator (phosphorus) and response indicators (chl-*a*, BOD<sub>5</sub>, diel DO flux, or pH)

are used in combination and not independently. The eutrophication rule clearly states the requirement that cause and at least one response indicators must both be exceeded to indicate a polluted condition.

Assessment staff should use the following information when assessing water bodies for the river eutrophication standard:

- **Primary and supplementary assessment statistics.** For chl-*a* and BOD<sub>5</sub> data, as with TP data, summer-means for the entire 10-year assessment period are calculated from the available data and considered in the assessment. Supplementary statistics such as number of observations and standard error are also generated. These statistics can aid determinations when an AUID is just above or just below the WQS or where stressor and response variables are not in full agreement.
- **Method detection limits (MDL) for BOD<sub>5</sub> data.** For most RES parameters, MDLs will not be an issue during assessments. For example, MDLs for TP (typically <10 µg/L) and chl-*a* (typically <0.5 µg/L) are well below the water quality standards (WQS) and less than values are uncommon. However, BOD<sub>5</sub> MDLs may vary among laboratories. MDL for BOD<sub>5</sub> data used in rule development was 0.5 mg/L (from MDH), which is well below the WQS. In other laboratories, the MDL may be 2.0 mg/L or higher. These MDLs are at or above the WQS for the North and Central RNRs and in some cases the South RNR. Following are cautions and considerations on the use of BOD<sub>5</sub> non-detect data in RES assessment (see also [Figure 5](#)). While BOD<sub>5</sub> is referred to specifically these considerations would also be applicable to TP and chl-*a* data where high MDLs were used and numerous non-detects are present in the assessment data.
  1. If the BOD<sub>5</sub> average is above the WQS and there are no non-detects, then the parameter does not meet the WQS.
  2. If the BOD<sub>5</sub> average is below the WQS, regardless of presence of non-detects, the parameter meets the WQS.
  3. If the BOD<sub>5</sub> average is above the WQS and non-detects are present, there are several methods that can be used for assessment depending on the dataset. These methods should be followed in sequence.
  4. If the BOD<sub>5</sub> average is above the WQS, but with more than 50% non-detects, the data is considered insufficient information.
  5. If the BOD<sub>5</sub> average is above the WQS and 50% or fewer are non-detects then:
    - a. Replace non-detects with “0” and recalculate the mean. If the recalculated mean is still above the standard, the concentration can be considered to exceed the standard. [The occurrence of non-detects in a dataset will increase the mean above the true value. This is because the reported non-detect value is higher than the true value. A simple method to determine if non-detects are potentially biasing the assessment is to use a best-case scenario. This is accomplished by replacing non-detects with “0” values. Since the true value is somewhere between the detection limit and “0”, this recalculated represents the lowest possible mean value.]
    - b. If replacing non-detects with “0” results in a recalculated mean that is below the standard, then more sophisticated mean estimation methods are required. If the BOD<sub>5</sub> data are critical to the assessment, advanced non-detect methods such as NADA in “R” may be required to allow for a more accurate estimate of the mean value. If the minimum detection limit for non-detect samples was greater than 0.5 mg/L, the data should not be used for assessment as such data was not used in the analysis for the WQS development.

Figure 5. Flow chart for addressing dataset containing non-detects.



- pH assessment.** Since pH assessments are based on the existing pH WQS, assessments should be done in accord with the existing methodology (i.e. the variable exceeds the standard if the data show a 10% exceedance of the WQS based on daily minimum and maximum measurements); however, pH data must be collected during the summer index period to be used as a part of RES assessment.
- Diel DO flux assessment.** Diel DO flux values are calculated based on the difference between the daily maximum DO and the daily minimum DO. These daily flux values are averaged based on the number of days of measurement. Heiskary et al. (2013; [Table 6](#)) provides an example of how data can be assembled for RES assessment purposes. The resulting average diel DO flux measurement is then compared to the WQS to determine if this response variable is met or exceeded.

- **Exceedances of BOD<sub>5</sub> or diel dissolved oxygen flux caused by other factors.** Indirect response measures can be influenced by other factors, which must be considered during the assessment. As with all assessment parameters, each is individually reviewed to determine if the site location was appropriate, if flow conditions and sampling regime were representative (e.g., not biased by flood or drought), and to ensure that there are no quality assurance issues with the data (e.g., data out of hold time, sonde calibration issues). When reviewing BOD<sub>5</sub> data, the proximity to permitted facilities must be taken into account as data included in the assessment may be within the mixing zone of the facilities discharge. These locations should be reviewed to determine if the discharge is biasing the values. For diel DO flux, flow conditions during deployment should be examined to determine if flow conditions were not typical and impacted diel DO flux measurement.
- **Clear evidence of WQS exceedance.** AUIDs exceed the RES if the causative variable (TP) exceeds the standard and one or more of the response variables (chl-*a*, BOD<sub>5</sub>, diel DO flux, or pH) also exceed the standard. Such AUIDs are impaired and the AUID will be included on Minnesota's 303(d) list. Not all response variables need to be present or in agreement for an exceedance to be determined.
- **Clear evidence of meeting the WQS.** An AUID is meeting the RES if total phosphorus is meeting the standard. A determination of full support of the RES does not require response data to be present. However, if response variable data are present and assessable, a determination of full support requires that the response variables also meet the applicable standard. An AUID can also be considered fully supporting if total phosphorus exceeds the threshold and all response variables can be assessed and they meet their respective standard.
- **Insufficient information to assess.** A determination of insufficient information will be assigned when:
  1. Insufficient data are present
    - a. Insufficient total phosphorus data available
    - b. Sufficient total phosphorus data are available and indicates exceedance of the standard, but no response variable data are present
  2. Sufficient data for assessment exists, but there is a lack of confidence in the data (e.g., inappropriate laboratory methods, atypical flow conditions, inappropriate sample location)
- **Average concentrations near the standard.** AUIDs where TP or response variable(s) are slightly above or slightly below the WQS require closer scrutiny of the data. A high standard error (SE), indicative of high variability in measurements, suggests the raw data should be reviewed to determine the frequency of elevated values. If  $TP \pm SE$  is just above the WQS but response WQS are met, the reach is deemed supporting the WQS. If  $TP \pm SE$  is just above the WQS and mean chl-*a*, BOD<sub>5</sub>, diel flux or pH exceeds the WQS, the reach is deemed not supporting aquatic life use due to eutrophication. If the data are not representative, such as poor site placement (i.e. lake outlet, in mixing zone of permitted facility), data skewed by drought- or flood-biased samples, etc. the reach may be considered insufficient information to assess. If flow data are available, this may help place results in perspective. For example, if summer-mean chl-*a* is equal to the response WQS but collections were made only during high flow summers, it is likely chl-*a* would exceed in summers with lower flow and it may be reasonable to recommend listing the AUID if TP exceeds as well. A recommendation of not listing may be reasonable if collections were made only during low flow summers.
- **Effect of impoundment ( $\geq 14$ -day residence time) upstream or within the AUID.** An impoundment immediately upstream or in the AUID may promote excessive algal growth even when TP meets the river eutrophication WQS. In instances like this, a decision may be needed as to whether the lake or river eutrophication WQS is most appropriate to address this situation. In



cases where the upstream impoundment has been deemed a reservoir and was assessed as impaired (based on the lake eutrophication standard (LES)), the “assessment status” of the river AUID may not affect the TMDL since the TMDL for the impoundment would likely address the river eutrophication issue.

- **Effect of impoundment (<14-day residence time) upstream or within the AUID.** Very small or short residence time impoundments or wetland complexes on the mainstem of a river (residence time < 14 days at 122-day one in 10-year low flow) represent a special case and there is a need to determine the status of data collected from reaches affected by these impoundments or wetlands in terms of 1) whether or not the data are assessable, 2) which if any standard is appropriate, and 3) how it may influence a downstream portion of the AUID. To determine if a river reach is impounded a review of dam location (DNR GIS layer), river morphology (aerial photos, site visits), water velocity, etc. will be used. The RES and LES standards were developed using data from un-impounded river stations and lakes that met the 14-day residence time threshold, respectively. These datasets did not include naturally or artificially impounded river reaches so the applicability of the either standard needs to be determined on a case-by-case basis. In most instances, best professional judgment will be used and documented to discern which standard is appropriate for the AUID in question. However, in some cases there will not be sufficient supporting information to determine an appropriate standard and data from the impounded section will need to be flagged as supporting information only. When an AUID includes data from both an impounded and un-impounded reaches, the data from the un-impounded reach may still be assessable against the RES standard.
- **Biased data.** As a part of the data review for assessments, RES datasets should be examined to identify possible biases resulting from irregular timing of sampling (e.g., samples weighted toward part of the year or to high flow events). If the data are not representative of the index period, a time-weighted average can be applied to correct this bias [note this procedure will only be needed when the bias is likely to have a significant impact on the assessment]. In addition to removing within-year temporal biases, the time-weighted average will also weight data from each year equally to reduce weighting toward years with larger sample sizes. However, caution should be used with data from years with few sample events (<4) or with data from only part of the year (e.g., only August samples). Years with only a single sample should be removed from the time-weighted calculation as the temporal weighting cannot be calculated for these years and the single sample would be given too much weight. Years with only two-three sample events should be scrutinized to determine how well the limited sample size reflects average annual conditions. These data may be removed or retained depending on this evaluation. Any data that are removed may still be useful as supporting information.

A time-weighted average can be calculated using the following equation.

$$TWA = \frac{\sum_1^n c_i * t_i}{\sum_1^n t_i}$$

where  $c_i$  = concentration for the  $i^{\text{th}}$  sample

$t_i$  = time window for the  $i^{\text{th}}$  sample

- **Site-specific standards option.** Sometimes it is more appropriate and information is available to derive standards based on information specific to an AUID. Site-specific standards require public comment and must be sent to EPA for approval. Additional data collection work may be required to develop and adopt a proposed site-specific WQS. Once approved, the site-specific standard becomes the basis for assessing the condition of the AUID.



- **Use of data near continuous discharging facilities.** BOD<sub>5</sub> and DO flux data from within five miles of a continuously discharging wastewater treatment facility (WWTF) are generally not valid for assessing RES. The intent of these response variables is to identify the presence of eutrophication (i.e. undesirable levels of sestonic or suspended algae, benthic or attached algae, or excessive rooted vegetation). Some river monitoring sites are too close to WWTF outfalls and are biased by dying microbial matter and not algae or rooted vegetation. A 2010 MPCA paper analyzed data and determined that in most instances, data from within five miles downstream of a facility may be impacted by the effluent. As a result, it would not be appropriate to use these values in a RES assessment.
- **Mississippi navigational pool assessments.** Navigational pool eutrophication assessments on the Mississippi River should be consistent with other 303(d) assessments; whereby the most recent 10 years of data would be used in the assessment. This should minimize the effect of any extreme high or low flow year and allow for a more comprehensive assessment of each assessment reach.
- **Assessments will be based on monitoring data collected in the thalweg of the pools just upstream of the dam that forms the pool.** The monitoring sites should be consistent with long-term monitoring sites employed by the Metropolitan Council (MCES) and USGS's Long Term Resource Monitoring Program (LTRMP) (see [Table 14](#)). The pool is designated as impaired if TP and chl-*a* exceed the WQS as noted in [Table 4](#) of Heiskary and Wasley (2012).

**Table 14. Station data used for Mississippi River pools assessments**

Pool	AUID	Stations used for standard development and assessment
Pool 1	07010206-808	MCES 847.7, EQuIS S004-276
Pool 2	07010206-806	MCES 815.6, EQuIS S000-068
Pool 3	07040001-718	LTRMP M796.9, MCES 796.9, EQuIS S005-179, S000-132
Pool 4/Lake Pepin	25-0001-00	LTRMP M766.0I, 771.2P, 775.6Q, 781.2O
Pool 5	07040003-F26	LTRMP M738, EQuIS S000-287
Pool 6	07040003-F27	EQuIS S000-095
Pool 7	07040003-F28	LTRMP M701.1
Pool 8	07060001-692	LTRMP M679.5, EQuIS S000-094

- **Lake Pepin assessments.** Lake Pepin assessments will be based on fixed site monitoring data and incorporate the most recent 10 years of data. This data is collected at two sites in the upper segment and two sites in the lower segment of the lake and correspond to long-term sites that have been used by LTRMP and MPCA. Data from these four sites were the primary basis for listing Lake Pepin as impaired and supported much of the model development and testing. Data from all four sites are averaged for the assessment. Site maps and further description are found in Heiskary and Wasley (2011).

### Special assessment situations related to RNR assignment

When assessments are made or new AUIDs are established, there may be a need to assign new RNRs or to change an RNR designation because of new information that is gathered in the assessment process. This may occur as a part of the professional judgment group review, as a result of public comment, or in the course of TMDL development. In some instances, this may require some correction in RNR designation, while in others it may require development of a site-specific standard.

Some stream reaches may require site-specific standards within the context of the RNRs ([Figure 4](#)). These situations most often occur when two similar order (sized) rivers from two different RNRs join prior to discharging to a major downstream, higher order river. For example, in adoption of the river eutrophication standards Exhibit EU-5 notes: *“In a few instances where two HUC-8s meet prior to entering the major mainstem river (e.g. North Fork and South Fork Crow Rivers) “blended” or site-specific standards are recommended and these reaches are noted on the RNR map.”* Where and when such sites are identified in the future, the site-specific WQS for the causative variable (TP) is likely to be based on the midpoint between the values from the two contributing RNRs. The site-specific WQSs for the response variables will be based on the midpoint between the WQS in [Table 11](#) of Heiskary et al. 2013. This approach and values as noted in [Table 11](#) of Heiskary et al. 2013 should be applicable in other instances where this may occur.

